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ABSTRACT

This study, conducted by the Metropolitan Communications Steering Committee for the Board on Telecommunications-Computer Applications of the National Research Council, identifies telecommunications technologies that could provide useful services for homes, businesses, and governments up to the year 1980. The present state of telecommunication needs and opportunities in metropolitan areas and potential urban applications of telecommunications were examined in light of rapidly evolving technologies and the relative economy of telecommunications. Four major advances in technology were identified as likely to lead in the near future to significant changes in metropolitan telecommunications: increasingly capable terminals, software controlled networks, cellular mobile communications, and fiber-optic cables. Telecommunications applications are considered in such areas as business aids, reference sources, entertainment, government administration, the environment, health, education, welfare, emergency and mobile services, and citizen safety. Within each of these areas telecommunications were reviewed in their capacity to improve efficiency and reduce costs, increase timeliness and accessibility of information, and facilitate public access. (Author/RAO)

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Telecommunications for Metropolitan Areas:

Near-Term Needs and Opportunities

A Report by the
Steering Committee for the
Metropolitan Communications Systems Study
of the
Committee on Telecommunications
Assembly of Engineering
National Research Council

NATIONAL ACADEMY OF SCIENCES
Washington, D.C. 1977

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NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Preface

The Committee on Telecommunications was established by the National Academy of Engineering in 1968 to provide support for the Presidential Task Force on Telecommunications Policy. Since 1974 it has been part of the Assembly of Engineering of the National Research Council, which conducts studies of scientific and technical issues on behalf of the National Academy of Sciences and the National Academy of Engineering. From the start the committee has placed special emphasis on telecommunications and information systems for meeting the needs and goals of the nation. Particular attention has been given to the social and economic impacts of telecommunications technology and the implications for federal policies.

In this connection, the committee has completed two studies of telecommunications applications to urban problems. The first resulted in the report "Communications Technology for Urban Improvement," which recommended a number of technology-based demonstrations of communications projects to improve metropolitan area services. The second led to the report entitled "Local Government Information Systems --A Study of USAC and the Future Application of Computer Technology,"* recommending the establishment of an information systems resource center to facilitate the incorporation of computer-based information systems by local governments.

The study culminating in this report was sponsored jointly by the Departments of Commerce; Health, Education, and Welfare; Transportation; and Housing and Urban Development; the Federal Communications Commission; the National Science Foundation, and the U. S. Postal Service. The primary objectives of the study were:

- to review and evaluate the present and evolving telecommunications technology in relation to foreseen metropolitan needs and opportunities, and

- to investigate the potential for integrating facilities and services to achieve greater effectiveness in telecommunications usage.

To accomplish these tasks, the Committee on Telecommunications formed the Steering Committee for the Metropolitan Communications Systems Study. Its members have brought to bear a broad knowledge and

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*USAC - Urban Information Systems Interagency Committee

understanding of telecommunications technologies, applications and their potential impact on the complex problems confronting metropolitan areas today. In addition, the steering committee included local government officials, business leaders, and regional planners. While the report addresses primarily metropolitan areas, many of the applications and technologies discussed may be of benefit to suburban and rural areas.

Members of the committee contributed papers to the study on their area of expertise. These papers, which cover a wide spectrum of telecommunications technology and potential applications in metropolitan areas, were used by the committee to form the various sections of this report. These papers, organized by subject and listed at the end of this report, are on file with the committee.

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Acknowledgments

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The committee appreciates the special assistance provided by Mayor William Donald Schaefer's staff of the City of Baltimore, Md. Marvin M. Rimmerman, the city's Director of Telecommunications, furnished much useful information on Baltimore's operating experience with telecommunications. His assistance in coordinating committee staff meetings with city officials was very helpful. In addition, Edward W. Messinger, Jr., Director of the Department of Communications, County of Los Angeles, California, provided special insight on telecommunications systems planning in a large urban-suburban setting.

Other individuals who were of great assistance are: Richard C. Stiles, General Telephone and Electronics Laboratories, Inc.; Professors Jonathan Allen, Robert M. Fano, and Robert S. Kennedy of the Massachusetts Institute of Technology; Charles R. Elmendorf and Donald L. Miller of the American Telephone and Telegraph Company; Richard Harkness of the Stanford Research Institute, Roger Pye of the Communications Studies Group of University College, London, England; Jerry A. Lebo of the Defense Communications Agency, David J. Leroy of the Corporation for Public Broadcasting; Lewis S. Norman of the Communications Satellite Corporation; John V. Bowser of United Telecommunications, Incorporated; John W. Neuenschwander of the General Electric Company; Maxine Rockoff, William Anthony, and Arthur S. Melmed of the Department of Health, Education, and Welfare; Robert G. Lunche and Eric E. Lemke of the County of Los Angeles, Southern California Air Pollution Control District; and Mrs. Bonnie Kraig of the Goldmark Communications Corporation.

The committee appreciates the enthusiasm and diligence of Ms. Gwynne S. Ellsworth, Mrs. Jean Cleveland, and Mrs. Margaret A. Smith of the staff who provided administrative support during the study and the preparation of this report, as well as the assistance of Frank M. Snyder who acted as executive secretary during final review and editing.

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CHAPTER I
Introduction

Telecommunications-information networks in the nation's cities and metropolitan areas are often compared with the human nervous system. In modern urban life, a multiplicity of signals, messages, and data are transmitted by wires, cables, and radio waves as instantaneously as the millions of nerve impulses in the human body.

Communications of one sort or another have been central to the character and condition of all cities since ancient times. In the world's oldest cities, those of the Mesopotamian valleys, rudimentary forms of communication were important in enhancing interaction among the ruling elite and merchant class and in informing and controlling the rest of the populace in collecting taxes, suppressing revolts, and quelling attacks. This was more or less true until the rise of the industrial cities, in the period between 1750 and 1850. Thereafter, new technologies radically changed the size, shape, and social organization of cities. Among those new technologies was electronic communications, which had its origin in 1844 when Samuel F. B. Morse sent dot-dash messages over a single wire strung on poles between Baltimore and Washington. Telecommunications and information systems are now extensive and virtually universal in all metropolitan areas. Such systems include the switched telephone network, television and radio, cable television, public telegraph, private line data and voice networks, and mobile radio.

Today, telecommunications is vital in business and social relations as well as in, for example, directing traffic, monitoring air and water pollution, detecting and controlling crime, riots, and fires, and relaying information about such varied matters as school programs, power failures, health care, welfare payments, and storm warnings.

Technologically, telecommunications has helped the complex, modern metropolitan areas to function better. When the telecommunications channels broke down during the Watts riots in 1968, the Los Angeles area was in chaos. When traffic signals, telephones, and car and transister radios continued working throughout the electricity blackout in New York's metropolitan area in 1969, many functions continued in an orderly fashion. By contrast, in February 1975, when fire destroyed one of the principal telephone centers in midtown Manhattan, the business and social life of New York was abruptly restricted. By itself,

of course, telecommunications cannot solve the problems or overcome the inadequacies of the nation's cities. Nor does the promise of telecommunications technology necessarily ensure that its potential will be realized. In examining the present state of this technology and the needs and opportunities in metropolitan areas in the next few years -- the subject of this report -- the committee recognized that there is little economic and social evidence to support the degree to which fully marshalled telecommunications and information systems could help overcome the contemporary crises of urban centers. Notwithstanding these uncertainties, the committee has undertaken to examine the potential urban applications of telecommuniucations made possible by rapidly evolving technologies and the relative economy of telecommunications.

The committee approached its task from a number of perspectives which form the substance of this report. These are:

- Evolving Near Term Telecommunications Technologies (Chapter II Section 1)
- Network and Systems Integration of Telecommunications Applications (Chapter II Section 2)
- Economic Considerations (Chapter II Section 3)
- Potential Applications of Telecommunications (Chapter III)
- Ten Telecommunications-Related Issues (Addendum)

Four major advances in technology are identifed as likely to lead in the near future to significant changes in metropolitan telecommunications: increasingly capable terminals, software controlled networks, cellular mobile communications, and fiber-optic cables. Yet, as these technologies become incorporated into communications networks, it is not expected that the communications infrastructure in urban areas will change in character. Rather, progress will be evolutionary.

The committee has concluded that the contribution of telecommunications toward solving the problems of the cities requires more explicit definition of the operational systems that will be used to increase the efficiency of local governments and to deal with major metropolitan problems.

Whether telecommunications networks and facilities for different services should be integrated is a question which involves complex tradeoffs between system cost and capacity and grade of service. Between the points of lowest cost and best service lies a range of optimal choices. Seeking commonality in service needs as well as facilities is perceived as a most useful approach for applying the telecommunications potential to metropolitan area functions. Single purpose networks utilizing some multipurpose links in existing facility networks are likely to be the outcome of this approach within the framework of existing and near-term technologies.

Because the demand for telecommunications services is derived from demands for other services, economic considerations are complicated and differ between the private and public sectors. While it appears that private sector services are being met adequately by the available telecommunications technology and the pluralistic structure of the industry, the committee found it difficult to determine whether public sector services, not normally rationed or subject to the price mechanism, are adequately supported by telecommunications.

While a broad range of telecommunications applications was considered, the committee selected only five areas for concentration: 1) business aids, reference sources, and entertainment, 2) government administration and the natural environment, 3) health, education and welfare, 4) emergency and mobile services, and 5) citizen safety. Within each of these, the committee reviewed specific applications, emphasizing the use of telecommunications to:

- Improve efficiency and reduce costs,
- Increase timeliness and accessibility of information, and
- Facilitate public access.

Finally, the committee responded to ten telecommunications-related issues selected jointly by the committee and the federal agencies concerned. While some of the issues relate only to metropolitan areas, others involve telecommunications in a wider context.

Summary and Conclusions

Upon reviewing the advances in telecommunications technologies, the opportunites for integration, and the economic factors (all outlined in Chapter II), and the many potential areas for applications (Chapter III), the committee arrived at the following observations and conclusions:

1. While telecommunications already provides significant services to assist in the management and operation of private and public functions in metropolitan areas, many more opportunities remain, not only to increase the effectiveness of existing services, but also to offer wholly new services. The growing importance of telecommunications suggests that urban planners recognize its possibilities in a more analytical manner. The urban needs and technological possibilities should be aggregated and assessed in any effort toward more effective planning. It is more important to aggregate needs and bring them into sharper focus than to seek new technologies. Most of the basic technical tools are at hand. In this regard, the committee found that:

- Current telecommunications technology offers opportunities for applications in health, education, and welfare, even though terminals for these applications still need to be developed. Such terminals appear close at hand. The majority of the telecommunications transmission and switching facilities required appear to be available in present and developing communications systems. But application of telecommunications technology alone is insufficient to solve the many chronic, intractable problems of health care delivery, education, and welfare assistance.

- Telecommunication technology is important to support, implement, and regulate certain programs of the metropolitan areas. Reductions in cost and improvements in capabilities of existing communication services can be expected as a result of improved engineering of available facilities and networks. However, significant advances in the use of sophisticated telecommunications technologies require more explicit definitions of the operational systems intended to achieve the efficiency and effectiveness of the largely governmental organizations

responsible for health, education, welfare, judicial, police, fire protection, and environmental safeguard functions. This is the central issue. New technologies are often exciting and interesting, but concern with them must not be substituted for hard operational systems analyses of the functions that must be performed.

2. It cannot be assumed that the most cost-effective response of telecommunications to metropolitan needs and opportunities is the integration of facilities and services. Many dissimilar requirements are recognized. Complete integration may either lead to less effective compromises or result in extra costs when compared to lower levels of integrated system design. Before the optimum level of integration can be determined, a study of the situation will need to be made. The committee suggests that the following conclusions will be helpful in carrying out such a study:

- The Switched Voice Network -- At present, it is capable of satisfying most technological requirements for business aids and reference service applications, which suggests a high potential for integration. Different network requirements, mainly broadband, for entertainment and cultural applications offer a relatively low potential for integration with these other systems using present technologies, but coordination is still a requirement. In the future, new developments may increase the potential for integration.

- Metropolitan Area Communications Networks -- To accomplish this type of integration, particularly within the framework of existing and near-term technologies, the operational systems approach appears to be the most immediately useful technique. Looking forward five to ten years, basic work on such advances as coding in customer terminals, digital multiplexing, digital carrier, and, most importantly, fiber optics, may promote the development of multipurpose integrated networks.

3. The telecommunications and information system requirements associated with such governmental and civic services as general administration, health care, education, welfare, the judicial system, fire and police protection, and environmental protection need to be better defined by urban planners and managers. The committee has concluded that it may be impossible to take full advantage of telecommunications potentials without some changes in the management structures in urban administrations. Opportunities exist for achieving better results through the use of telecommunications, but greater emphasis needs to be placed on creating an awareness of potentials in the local government management process. The disciplines necessary to make computer communications systems work effectively should be incorporated into urban administrations. To accomplish this, the following should be considered:

- Each central administration of a substantial governmental unit (state, county, city) needs to establish a focal point for all

functions related to telecommunications and information systems. For example, the City of Baltimore has established an Office of Telecommunications that reports directly to the mayor. The County of Los Angeles has a Department of Communications responsible for all communications planning in the county. The local telecommunications focal point needs to develop an integrated plan, based upon cost-benefit analyses, for the use of telecommunications and information systems technology for all unit services. By grouping and integrating urban needs, planners and managers can often determine how to improve services, increase reliability, and simultaneously lower the costs of both the equipment and services available from the telecommunications and information systems industry.

CHAPTER II
Technological Considerations

SECTION 1: METROPOLITAN TELECOMMUNICATIONS TECHNOLOGY

Telecommunications is a vital and dynamic component of the infrastructure of today's metropolitan areas. This being so, existing and new telecommunications technologies hold the promise of improving the efficiency and effectiveness of almost every business and governmental operation in urban life as well as improving the condition of its inhabitants. Realizing this promise requires an iterative planning process that involves the selection of highly specific functions. These include: 1) the determination of the objectives and features of the operational systems* required for particular functions, 2) the evaluation of the geographic, organizational, economic, political, and legal constraints on the operational systems, 3) the definition of the communications capabilities required by the operational system, and 4) the design and evaluation of alternative telecommunications service networks** to meet the designated needs.

Planners of operational systems should consider the performance and costs of existing and new telecommunications technologies, as well as the possibilities of combining service and facility networks. The purpose of this section is to review the existing and near-term technologies and to indicate how to plan for their application; the next section of this chapter considers the possibilities for combining networks, and the final section assesses the economic factors.

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* Operational Systems are here defined as the flow of activities required to carry out a specific personal, business or governmental function.

** Service Networks are defined as the aggregation of customer terminals, loops, trunks, switches, processors, and maintenance equipment required to provide end-to-end service to users. In this taxonomy, Facility Networks are aggregations of links and nodes which provide the components of service networks.

Existing and Near Term Telecommunications Technologies

The basic technologies now exist to translate any voice, data, or picture message into analog or digital signals and to transmit, switch, and process these signals in a wide variety of network configurations. Switched and private line voice, record, and low to medium speed data (10 kilobits per second) services are provided by the telephone network. Higher speed data, facsimile, point-to-point video, and mobile services are provided by specialized private and common carrier networks. Broadcast services are provided by radio and television stations and the growing cable television networks.

Substantial engineering applications of new technologies will result in evolutionary performance improvements and feature additions as well as reductions in "constant dollar" costs of these services. The present telecommunications capabilities can meet many of the requirements for new operational systems, but these will not change the character of the communications infrastructure in metropolitan areas.

The major advances in technology that can contribute to significant changes in metropolitan area communications in the next five years are:

1. Specialized and general purpose user terminals involving cathode ray tubes, plasma displays, and new printing techniques. Microelectronic technology, as exemplified by the microprocessor on a chip, will lead to significantly increased terminal sophistication. This will have considerable impact on communications system architecture.

2. Software controlled networks involving distributed processors for signal conversion, storage, formatting, routing, and error control.

3. Glass fiberguide transmission systems for multiplexed voice, data and picture signals. 1/

4. Cellular mobile communications networks operating in the 900 mHz band and utilizing stored program controlled switching machines to optimize spectrum use. 2,3/

Digital transmission, switching, and their integration could be listed as a fifth major advance, but these may also be considered as a part of the rapid evolution of the switched and private line telecommunications networks. 4,5/

Communications satellites are expected to be more widely used for intercity connections and to provide communications services to large and distant rural areas. Few, if any, uses of satellites are foreseen within cities because of the comparative cost advantage of alternative terrestrial facilities. In addition, there are services that may be affected by delays in transmission time resulting from the use of satellites as the transmission medium.

Telecommunications Technology Application Planning

Little, if any, definitive and detailed information on needs and costs is available upon which to synthesize new service networks. Rather, there is a plethora of ideas and proposals that might be technically possible, but may not be economically attractive or feasible in the organizational or operational sense. These observations emphasize the need for the disciplined planning of operational systems.

Notwithstanding the lack of explicit information on telecommunications capabilities that users can justify operationally and economically, it is clear that existing and near-term technology can provide the component channels, controls, switching, and signal processing capabilities required by most of the operational functions identified earlier. Moreover, numerous opportunities exist for adapting the types of loops, trunks, and switches that form the urban facility networks, as well as for the provision of new and enhanced services. Not surprisingly, the problems and challenges lie in the economical aggregation of more or less available techniques to provide viable service networks that may or may not serve several functions.

The planning and direction of technology-based studies are carried out in the following three distinct but coupled categories:

1. Engineering application of available facility network components to improve and enhance existing types of services. The need for a managed, combined voice and data network of a governmental entity is one example.

2. Engineering application of available types of channels to provide links in specialized service networks. Alarm, sensing, and control channels for environmental monitoring, traffic control, and premise surveillance; and the numerous types of data links for all manner of business and governmental operations are examples.

3. Planning studies for advanced technologies that may make possible telecommunications capabilities that are substantially different from existing services. The complex data-base oriented networks for managing welfare operations, an interactive audio-visual-data network for health care, a combination of education, entertainment and business video networks, and vehicular location and control systems are examples.

The engineering application studies in categories 1 and 2 can be carried out jointly by the communications industry and business or governmental organizations requiring service. Defining the needs and balancing them against costs is all that is required. In making such studies, user organizations should explicitly establish a range of possible requirements that will meet their needs, and vendors should provide realistic performance and cost data. Dependence on undeveloped, even though promising, advanced technologies should be avoided. In

addition, any assumed cross-subsidies among organizations should be clearly identified and their acceptance verified.

Pending the availability of more clearly defined operational requirements, it becomes necessary for the R & D organizations, manufacturers, and carriers, who are nurturing these technologies, to invent, propose, and market components and network services on the basis of their perceptions of customer needs and their planning studies in category 3.

It is likely that the service network features considered important by potential users are: (1) economical user terminals matched to the requirements of one or more operational system functions; (2) sophisticated signal processing and control; (3) low cost broadband channels to widely dispersed customer locations ; (4) substantial increases in the efficient utilization of radio frequencies allocated for mobile communications; and (5) low cost narrowband switched data networks. Significantly, advanced technologies, forthcoming in the near future, are directed to these problems.

SECTION 2: NETWORKS AND SYSTEMS INTEGRATION

In addition to opportunities for applying telecommunications technologies to the problems of the cities, there exists the tantalizing proposition that integration of existing metropolitan communications systems could lead to new metropolitan functions or could improve the performance and efficiency of continuing functions. The overall subject of integration is both broad and complex and requires careful analysis. Accordingly, the committee has chosen to develop an overall understanding of the issue from several perspectives that involve:

- Combining operational systems
- Combining communications networks
- Planning networks
- Analyzing integration potential

This approach provided the basis for the committee's evaluation of the concept of integration.

Combining Operational Systems

The technical and trade literature contains many ideas for using telecommunications technology to support what is perceived to be socially desirable functions. Examples of public services likely to derive benefits from the application of telecommunications technology are: education, through computer-aided instruction and remote video presentations; health care delivery, through audio, data, and video communications; crime prevention, through improved reporting and computer aided information retrieval and dispatching capability; and public assistance management and information distribution, by applying various forms of communications and data systems.

The combination of operations within or between broad social services (i.e. education, health care, crime prevention, public assistance, etc.) is severely handicapped by a lack of agreement on the functions, standards, objectives, and responsibilities among autonomous public administrative units. Combining telecommunications requirements into multipurpose networks involves resolving cost allocation and cross-subsidy problems that are charged with political, economic, and social values. For example: Should telecommunications

for socially desirable services such as education, health care, crime prevention, and public assistance be subsidized by telecommunications for entertainment and business operations that are priced above the real costs? How such a question is addressed and answered is critical to system concepts.

Chapter III surveys, catalogs, and reports on a large number of public service operational systems that should benefit from improved telecommunications capabilities. This is a necessary first step in the process of defining practical cost-effective telecommunications capabilities, developing broadly applicable agreements across organizational boundaries, and resolving cost allocations and subsidy questions.

To provide further insight into combinational opportunities in operational systems, the following additional tasks would have to be to be undertaken:

- Developing a methodology for defining specific and limited operational systems in socially useful fields;
- Explicitly identifying and delineating the intra- and inter-organizational problems involved in integrating specific operational systems and telecommunications networks;
- Assessing costs for various telecommunications capabilities with present and near-term technologies.

With such information in hand, one could then think explicitly about possible integrated telecommunications networks. The extent to which they would be considered desirable and economically acceptable is conjectural at this point.

These comments apply particularly to the social and administrative functions of government or non-profit organizations. With most private business and entertainment functions, such as new data communications services, electronic funds transfer, electronic record communications, and entertainment television, the profit motive of regulated and unregulated business will continue to foster large expenditures for operational systems planning and R & D. Indeed, trade and technical literature already covers service concepts, experiments, and commercial proposals in the private sector.

Combining Communications Networks

A common goal for telecommunications users and providers has been--and will continue to be--to increase the common usage of facilities by various services. Full attainment of this goal in urban areas, however, will be limited by the economic contributions of technology, the cost of reaching dispersed customer locations, and service features. The need for specialized channels to accommodate differences between baseband signal characteristics, customer service points, switching hierarchies, terminals, and operating arrangements

has led to specialized service networks (vs. newly optimized multipurpose facility networks). Yet specialized service networks have been possible only because existing facility networks have proven to be useful foundations upon which to build.

Thus, in long-haul inter-city communications, different radio frequency channels on common routes are used for increasing multiplexed voice (and voiceband data), television channels, and, most recently, data-under-voice (DUV).

In urban areas, separate wire pairs in large facility cross sections are used for either voice, data up to 56 kilobits per second, or, with severe restrictions, baseband video. Common use is made of poles, underground structures, cable sheaths and buildings--but not channel electronics. Also, 1.5-3 megabit signals carrying voice and data can be transmitted on repeatered wire pairs that are carefully engineered. Coaxial cable systems can be used for 274 megabit digital channels carrying different services or for multichannel analog television (CATV) that may also be used for data. Here, multiple use of these facility network links depends on the concentration of large amounts of traffic over specific routes.

Based on this understanding, two critical observations can be drawn:

1. Except for alternate voice/data services on voice-band channels, multipurpose use of common communications links is largely limited to facility networks rather than service networks.

2. Economies of scale are derived from (a) traffic concentration; (b) sharing of structures, buildings, ancillary equipment (e.g. power); (c) facility design; and (d) integrating maintenance operations. The scale, and the resulting economies that may be obtained, are limited not only by the level of user demand, but also by other significant considerations.

Even so, the basic question is left open on the extent to which economical multipurpose service networks can be defined and implemented. Distinct opportunities exist for gaining commonality in the facility network portion of service networks. But going beyond this into terminal design and operational control involves identifying and solving organizational problems and understanding the realistic technical and cost factors involved in providing various kinds of telecommunications in both singular and combined forms.

Planning the Networks

Experience teaches two facts that are based in the logic of topology, traffic theory, and communication theory.

First, customer terminals and the access channels most often represent the largest cost of user-oriented, telecommunications networks. This results from the geographical dispersal of customers and the low usage of individual terminals.

Second, increased information flow in the form of wider bandwidths or higher bit rates results in higher costs for terminals and channels. Amplification to overcome media loss, amplitude and delay equalization to preserve signal identity, multiplexing to combine signals, and coding to generate signals more compatible with available channels also add to the costs. By contrast, switching and trunk transmission are less costly and restrictive because these can be handled centrally and in bulk.

The distribution of voice, high-bit-rate data and video signals in cities have evolved using separate facility networks, in part because of the large differences in signal format and the sensitivities to interference and distortion. The basic costs of wire pairs, coaxials, radio terminals, multiplexers, linear amplifiers and equalizers, and regenerators are important reasons for this service network differentiation.

The customer loop telephone plant is economical for voice and voiceband data. However, its use for data signals in excess of about 10 kilobits per second requires costly pair selection, equalization, and regeneration. With T Carrier digital transmission, conventional wire pairs can be used for up to about 3 megabits, although this requires costly engineering and regenerative repeaters spaced at 1 mile intervals along a route. This technology is cost-effective only for routes with 10 systems or more. Thus, high-bit-rate and/or individual video customer access lines are not yet generally available.

Access lines that are widely dispersed require an extremely complex and dynamic facility network. Economics, technology, and the sheer size of these networks make rapid change difficult. Notwithstanding, steady progress is being made in applying new technology to reduce cost and extend the service capability of this vital part of the telecommunications network. The hope for truly high-bit-rate and video access lines becoming generally available will most likely depend upon the development of digital carriers on wire pairs and optical fiber utilizing digital carrier or baseband video. However, much basic research and development work is required before the cost and practical usage pattern of these technologies are known.

If and when shared access lines do become available, voice, high-bit-rate data, and video signals can be most readily accomplished on common channels and switches by coding the signals in digital formats. While, at present, the coding of voice and video signals on the customers's premises is too expensive for general widespread use, continuing developments in integrated solid state electronics should reduce the costs. Here it must be emphasized that the extent to which combined voice and high-bit-rate data services, and possibly video services, become available at the customer's premises will depend not so much on improvements in signal coding, but, more significantly, on the cost and availability of high-bit-rate customer access channels.

Analyzing the Integration Potential

Turning to yet another aspect, the committee prepared a matrix chart (Table I, pages 18-19) to incorporate the factors identified above

and to analyze the potential opportunities for facility and systems integration. The matrix identified specific applications being addressed on the vertical side of the chart and the technology and other related factors horizontally across the top of the chart. An example to which this chart was applied is shown in Table V (Chapter III, Section 1, page 36).

Such an analysis via a matrix offers a useful overview of the entire issue. The headings on the two axes suggest broad generalizations and patterns. For instance, one can observe that many of the applications could probably be supported by the evolutionary growth of the present public telephone service network; yet without further analysis it cannot be automatically concluded that this would necessarily be the most economical means.

The matrix also demonstrates that the broad specifications for many of the communications service requirements are still unclear or uncertain and hence difficult to fit into patterns. This is particularly noticeable in public sector services such as health care and education. By contrast, business service requirements were more easily identifiable, and hence it was possible to fill in the matrix for these applications (see Table V, Chapter III, Section 1, page 36). One reason for this variation has already been noted; that profit-oriented businesses devote adequate resources for operational systems planning and R & D to satisfy demands that offer a reasonable return on investments. The system in effect forces planning toward optimal integration. To compensate for the lack of similar forces in the public sector, resource assistance may be required to develop demonstration or pilot service systems that are integrated and to evaluate their future feasibility.

Overview

While these four perspectives were useful, none could fully answer the question: How completely can separate facilities and services be integrated before exceeding the optimum cost/benefit ratio?

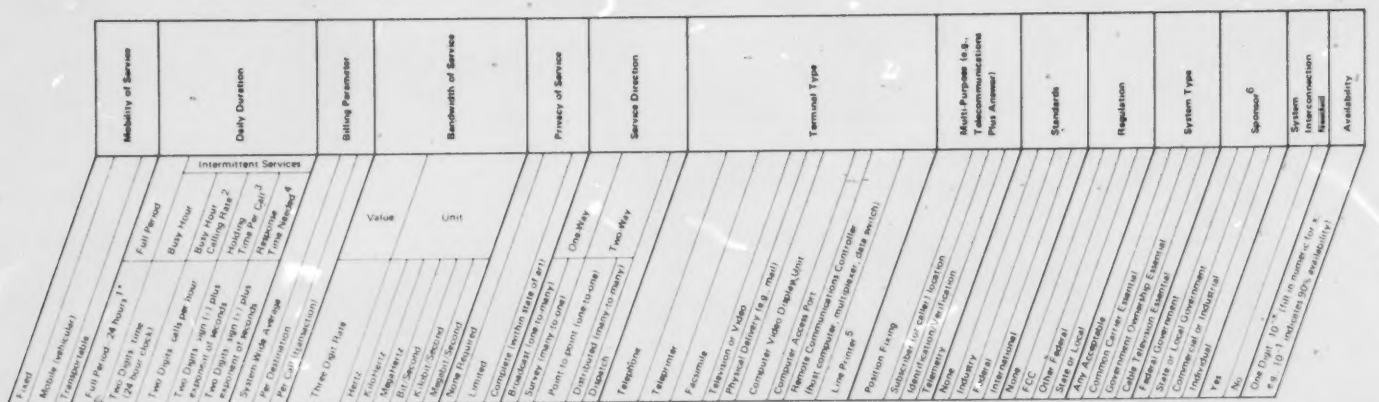
Integration can be studied under two headings: integration of the needs of disaggregated potential users of certain services and integration of dissimilar services. If demand for the services can be integrated, a better opportunity exists for integrating the hardware and software systems to implement the services. In addition, integrating the demands for service with the means to provide it is a natural goal in a productivity-oriented economy.

But more integration does not naturally lead to more benefits at lower cost -- particularly as the integration leads increasingly to increased complexity and counterproductive combinations.

The trade-off issues are graphically displayed in Table II, page 20. Each of the numbered curves in Table II is described below:

1. System hardware costs (per unit of information handled) will decrease as there is an increasing integration of service needs. This increase is that typically shown in a single facility where total demand can be aggregated

TABLE I



APPLICATIONS

HEALTH EDUCATION AND WELFARE PANEL

Health Care

- Out Patient Care
- In Patient Care
- Telemedicine
- Patient Appointments
- Physician-Specialist
- Physician-Health Worker
- Information Centers
- Preventive Medicine
- Laboratory Testing
- Continuing Health Educatio
- Tele-consultation
- Tele-clinics
- Patient Education
- Centralized Records
- Medical Libraries
- Administrative Management

Education-Training

- Computer Assist.
- Special Education
- Adult Education
- Off-campus Education
- Two Way Video
- One Way Video-Audio
- Record & Administration

Social Welfare Services

- Public Housing
- Family Services
- Income Maintenance
- Community Services
- Food Stamps
- Master File Clearance
- Administration
- Records and Reports

Technology Interaction

REFERENCE SOURCES, BUSINESS AIDS, ENTERTAINMENT PANEL

Reference Sources

- Library Information Systems
- Item Search Systems
- Content Search Systems
- Multi-use Systems

Business Aids

- Video Conference Center
- Central Dictation Center
- Telephone Answering Service
- Information Center
- Employee Training
- Electronic Mail Center
- Industrial Parks Interconnect

Entertainment-Culture

- Pay Television
- Public Service

Technology Interaction

METRO SERVICES PANEL

Emergency Services

- Disaster Warning
- Emergency Broadcast
- Inter-system Integration
- Multi-language
- Fed '911' System
- Flood Sensors
- Tornado Detectors
- Poison Control Centers
- Medical Rescue
- Records and Reports

Citizen Safety

- Fire Dispatch
- Fire Alarm
- Police Dispatch
- Police Alarm
- Citizen Band
- Unlawful Entry Alarms
- Criminal Alert System
- Records and Reports

Transportation

- Private Automobiles
- Trucks
- Police Cars
- Taxis
- Ambulances
- Buses
- Mass (Rapid) Transit
- Main Line Rail
- Pipelines
- Ships
- Airplanes
- Transportation Services
- Records & Reports

Technology Interaction

URBAN INFORMATION SYSTEM INTERAGENCY COMMITTEE (USAC)

(This Panel is currently reviewing municipal information systems in five selected cities and is coordinating data with the "Government Administration and Environmental Panel")

GOVERNMENTAL ADMINISTRATION & ENVIRONMENT PANEL

Government Administration

- Municipal Information System
- Land Use Data Banks
- Policy Making
- Utilities Management
- Assessment and Tax Billing Administration
- City Finance System
- City Logistics System
- Capital Improvements
- Records and Reports

Environment

- Pollution Monitoring
- Airports
- Sewer
- Water
- Emissions
- Records & Reports & Administration

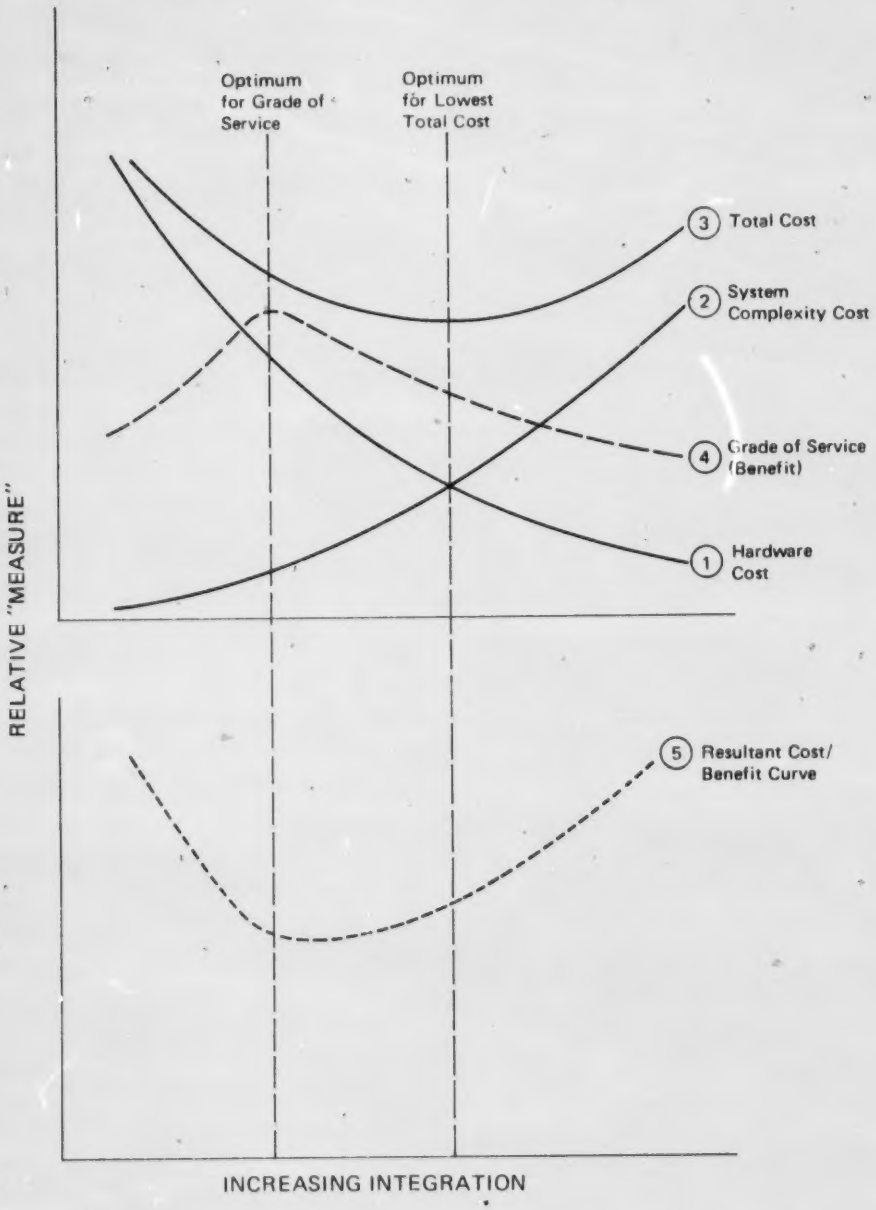
NEEDS OF THE CITY

- Economic Opportunity
- Justice (Legal Assistance)
- Law Enforcement
- Housing
- Energy
- Employment
- Population

U.S. POSTAL PANEL

- Administration
- Records & Reports
- Money Transfer
- Mailgram
- Electronic Message System
- Local Distribution (Domestic)
- International Distribution
- Fax
- Graphics
- Elec. Msg. to &/or from Post Offices
- Elec. Msg. to &/or from Homes
- Alpha/Numeric

TABLE II Integration Trade-Off Issues



economically. In practice, however, this demand is spread geographically. At some point, the cost to access an increased geographical area will offset the decline in hardware costs.

2. System complexity cost -- mostly in terms of software and maintenance needs -- will increase with increasing integration. Complexity increases geometrically as the number of dissimilar system interfaces increases.

3. Total cost then follows a saddle-shaped curve.

4. The benefit of the system -- generally referred to as grade and/or quality of service -- can be improved by some integration. Additional services can justify a service-conscious management with depth in trained operating and maintenance personnel. As integration increases, however, additional accommodations need to be made and compromises in service quality may result. Things that go wrong in one system can affect all systems. There are more potential customer load imbalances, and skills have to be spread thinner over an ever wider field of hardware and software.

5. By "ratioing" curve 3 to curve 4, one derives curve 5 as an indicator of the ultimate measure of cost-benefit. Note that there is a broad flat "optimum" that ranges between the points of lowest cost and best service.

In considering the integration of disaggregated services and hardware, the best choice is likely to fall between optimum sizes for cost and for quality of service. Determination of the proper mix and balance among the factors considered is best accomplished by the price mechanism of the market. But physical facilities in telecommunications require access to public resources -- i.e. sharing of rights of way or radio frequency spectrum. The consequence of this is that the optimum balance may not be obtained without government participation.

Additional factors can be brought into the analysis as an aid to closing in on the optimum points.

Technical factors that influence significantly the choice of hardware:

examples:
- bandwidth
- terminal mobility
- need for privacy
- terminal design
- system structure
- system interconnection (common network needs)

Service issues (or styles) that significantly pattern the software into styles of service:

examples:
- file search
- transaction
- computing
- monitoring
- correspondence
- conversation
- education/entertainment
- travel substitution

A display of the relationship between these styles and the fields with potential interest is given in Table III, page 23.

Socioeconomic issues that influence the final choices in the trade-offs:

examples:
- government/private industry "partnership"
- need for regulation
- cost/benefit "in the public interest"
- existence and competence of "suppliers"

The first two sets of factors (technical issues and service issues) can be related and then analyzed for potential integration opportunities via another matrix, as in Table IV (page 24), which is a simplified version of Table I. Introducing the socioeconomic issues into the matrix would be the final and indeed most complex and subjective step.

TABLE III Service Style Patterns

Service Styles	Fields with Potential Interest						
	Home	Educ.	Health	Public Safety	Transp.	Bus/Ind.	Research
File Search	X	X	X	X	X	X	X
Transaction	X					X	
Computing		X				X	X
Monitoring	X		X	X	X		X
Correspondence	X					X	
Conversational	X	X	X	X		X	
Educ/Entertainment	X	X	X	X		X	
Travel Subs.		X	X	X		X	

Service Style Definitions

File Search: an inquiry is made of an addressed file with proper search codes (300 baud) and response from file for display or print out is made at 1200 or 2400 baud; search may require interactive interaction between the file controller and the inquirer.

Transaction: a transaction required is addressed to the proper control center and after connection is acknowledged the transactor makes the entry and receives confirmation followed perhaps by some form of "receipt"; the signal in both directions generally would be at 300 baud.

Computing: similar to the above but the transaction is one of processing and computing thereby requiring much longer connect times and generally higher speed (1200 or 2400 baud) return for display and/or print out.

Monitoring: sensors are connected full time (or under clock time control) to a 1200 baud circuit; data is extracted by polling and data includes "address" of sensor as well as what it reports; data volume per sensor is low but full voice circuit is needed to speed frequency of polling process.

Correspondence: this can best be described as an updated form of Telex–higher speeds, higher quality, more routing and priority options etc.; most traffic will be handled at 1200 or 2400 baud in each direction.

Conversational: two way telephone service.

Education/ Entertainment: in some applications the service would be quite similar to that described under computing; in others, there might be full TV signal feedback either individually addressed or "party line."

Travel Substitution: in its early stages, potential conferees would all enter conference studios in their respective cities and conduct a meeting in full two-way TV; new scanning systems with bandwidth reduction may permit simultaneous transmission of several TV pictures on one TV channel if frame to frame motion is not a problem.

Possible Opportunities for Integration

Today's telephone network could satisfy most of the style and technical factors shown in Table IV, below:

TABLE IV Relationship of "Style" and "Technical" Issues

	BW[1]	Terminal Mobility[2]	Need for Privacy	Terminal Design[3]	System Structure[4]	System Interconnection[5]
File Search	VC	F	–	KB, D, PO	A/R	N
Transaction	kVC	F	√	C, KB, D, PO	A/R	N
Computing	VC, D	F	√	KB, PO, D	A/R	N or L
Monitoring	kVC	F	–	S	P	L
Correspondence	kVC	F	√	PO, KB	A/R	N
Conversational	VC	F, P, M	√	V	A/R	N
Educ/Entertainment	VC, TV	F	√	KB, D, PO, V	A/R	L, N
Travel Subs.	VC, TV	F	√	TV	A/R	N

[1] BW
kVC = part of voice channel
VC = 4KHz
D = 50 Kbits/sec
TV = 6 MHz

[2] Terminal Mobility
F = fixed
P = portable
M = mobile

[3] Terminal Design
V = voice
KB = key board
D = display
PO = print out
C = ID card reading
S = sensors
TV = TV camera + display

[4] System Structure
A = Ask
R = Reply
P = Poll

[5] System Interconnection
N = nationwide
L = local

The exceptions are:

- TV bandwidth for travel substitution, education, and entertainment opportunities;
- Variety of terminal design needs;
- Excess bandwidth for transaction, monitoring, and correspondence;
- Occasionally inadequate bandwidth for computing;
- Polling requirements for which it is not structured, and
- Portable and mobile conversational needs now met by other systems -- primarily local mobile radio systems.

Of these, only TV Bandwidth is a major limitation. The other exceptions can readily be overcome by expanding and developing the telephone network to enable acceptance of this breadth of "style" needs. For example, portable and mobile communications capabilities will be greatly increased with the advent of cellular and trunked systems that will handle 1000 to 1500 users on a single channel, in contrast to the present capacity that saturates a channel at about 50 users.

The range of "styles" will require a wide variety in terminal design. While opportunities exist for terminal design integration, the variability of the human factors at the terminal interface and the variety of software designs will probably preclude early integration into a singular, comprehensive terminal. However, the "elements" of a terminal might become quite common in design, thereby enabling introduction of mass production techniques. These "elements" could then be assembled to meet specific service needs.

Although a TV bandwidth network could be postulated as capable of total system integration, many service styles would be making only sub-optimal use of such a network. Unless inefficiencies could be accepted or tolerated, the ultimate potential physical integration of data, voice, and video facilities will have to wait upon further progress in fiber optic systems. But even that is dependent upon yet the other facet of the total problem, namely the socioeconomic issues.

Conclusions

Within the framework of existing and near-term technologies, the operational systems approach -- seeking commonality in service needs -- appears to be the most immediately useful technique for metropolitan area functions to gain from telecommunications potential. Single-purpose service networks utilizing some multi-purpose links in existing facility networks are likely to be the outcome of this approach.

Looking forward 5 to 10 years, basic work on coding in customer terminals, digital multiplexing, digital carrier and, most importantly, fiber optics systems, may allow projection of multipurpose networks. Finally, we must realize that advances will not occur unless the pertinent socioeconomic issues are addressed simultaneously with the other two axes of the matrix (Table I, pages 18-19).

SECTION 3: ECONOMIC CONSIDERATIONS

The richness of telecommunications technology is such that its possible applications and opportunities for integration are limited only by economics and human imagination. Home monitoring of ambulatory patients, computer-aided instruction, electronic funds transfer, and a host of other services are technologically feasible right now. Some services, such as pay TV, are growing and will continue to do so at least through 1980; others, such as facsimile to the home, are not even in the trial stage in the U. S., though they continue to be considered as cost and other factors change. The factors that tend to limit implementation and combination of these services are in many cases economic, although they may also be political, sociological, historical, regulatory, or legislative.

The review and analysis in this section considers, first, the general telecommunications economic environment; second, the private sector of the economy; and third, the economic factors related to public sector service.

Overview of the General Telecommunications Environment

In the past few years, the telecommunications market has experienced considerable growth. This is expected to continue at a substantial rate through 1980, although the growth will vary considerably in each market segment. In 1973 the Department of Commerce projected the annual growth rates for the various components of the market: 6/

- International telephone 29%
- Cable television (subscriber revenues only) 20%
- Domestic telegraph (including data transmission) 17%
- International telegraph (including data transmission) 16%
- Domestic telephone (including data transmission) 11%

Perhaps the most significant causal factors of this growth rate are the technological advances in the telecommunications and data processing industries. Advances in technology are expected to lead to an evolutionary reduction in constant-dollar costs for particular telecommunications applications and enable the continued development

of new conveniences and operational systems for end users. Advances in solid state digital intelligence and digital transmission channels should provide a key to new developments.

The rapidly expanding digital technology will also hasten the development of communications/computer networks. A low cost switched digital network is likely to be developed that will (1) satisfy a wide range of user needs, (2) receive input from any type of functional terminal, and (3) be available at reasonable prices.

Changes in the telecommunications market within both common and non-common carriers have also paralleled the advances in technology. For some time the goal of universal telephone service has been reached in the U. S. for both businesses and homes. Having achieved saturation of basic telephone service, new developments are being introduced to sustain the industry's growth. Thus, in the residential market, new equipment from both telephone company affiliates and independent manufacturers has brought about many novel services and conveniences such as automatic dialers and call forwarding. Businesses have access to a variety of new customer operating features. Convenience, at reduced operating cost, is the goal of these market-oriented developments.

Historically, the pricing of telecommunications services has emphasized the concept of "value of service". More recently, emphasis has been placed on cost-related pricing, particularly at the federal level. The shift away from flat-rate pricing may alter the calling habits in metropolitan areas. While precise forecasts of future calling patterns is not clear at this time, usage sensitive pricing of telephone service is certain to affect business, government, and residential calling habits.

Regulatory and legislative actions have also been important in the structuring of today's telecommunications market. Rate changes and new services are usually handled on an individual basis, with an occasional broader review. Federal and state commissions have sufficient authority to deal with any new telecommunications services, investment, or pricing concepts that either the government or the firms want to introduce.

Private Sector

In the present telecommunications environment, residential and business users have a great range of choice of facilities and services. The marketplace supports and encourages the development and implementation of new services made possible by the wealth of telecommunications technology. While it is not possible to state absolutely that all the needs in the private sector are being satisfied at affordable prices, the committee has not identified any major areas where services made possible through the available technology are not being developed by the telecommunications industry. It is reasonable to anticipate that this condition will continue so long as the existing legislative and regulatory climate exists.

Public Sector

In the past decade, metropolitan areas have experienced an increasing need for more and better communications. Among the causal factors are:

a. Growth in the interdependence of human goals, problems, and activities in many dimensions , such as geographical range, number of people involved, and number of different functions.

b. The growth of structural and operational complexity, resulting in part from attempts to cope with interdependence.

c. The rising expectations on the part of the population with respect to education, health care, employment opportunities, and access to economic and other resources. 7/

These categories encompass a variety of public sector functions and services from education to police protection and welfare. Telecommunications for these services is being satisfied largely by the mix of regulated and unregulated firms operating in the private sector.

Yet attempts to estimate the specific requirements for telecommunications in the provision of public sector goods and services are complicated by two factors. First, the demand for telecommunications stems from the demand for public services. Second, the supply of these services is not customarily rationed by the price mechanism.

Estimating the "derived demand" for telecommunications in such a setting stems from the need to forecast both the estimated demand for non-market goods and services and the associated demand for telecommunications to carry out these programs. The result of these complicating factors is a lack of sufficient data by which priorities for the use of telecommunications in metropolitan areas can be assessed. For example, it is difficult to rank the costs and benefits of technology utilization in the field of education. Not enough is known about educational production functions to say, for instance, that $1 billion spent on technology will raise reading scores by a certain percentage for a specific grade. Similarly, the value of a specific technological device, to aid a relatively small number of handicapped students to attain a certain academic level, can hardly be compared to the benefits that might derive when equivalent funds are applied to, say, rural schooling or cable TV education sectors.

Development of the capability and data to permit cost-benefit evaluations in those areas of particular importance for public sector offerings requires:

1) Implementation of a series of studies to determine the contribution of telecommunications in the provision of public goods and services.

2) Determination of who should accept primary development responsibility in these areas.

The second requirement involves the consideration of whether to rely alternatively on private firms, state and local governments, and/or the federal government.

The private firm can frequently contribute by translating the public sector derived demand for telecommunications into the method of providing least cost service. Knowledge of specific functions, requirements, and intentions for government programs, say of welfare, may not appear completely in private firm projections of needs. Therefore, the government will have to supplement and clarify the private firm projections so that the service can be developed and applied effectively.

State and local governments can assume some of this responsibility, especially given the importance of the metropolitan base. Needless to say, however, governments beset by budget problems and social priorities face difficult questions about the use of available funds. Under the circumstances, state and local governments often favor programs with an immediate payoff.

In some cases, the federal government may be best qualified to promote the development of telecommunications for urban areas. For example, the federal government can undertake the appropriate range of pilot studies and develop nationwide data bases that involve the consolidation of information and other factors of a non-local or multi-local nature. Such studies or programs may require that planning and data gathering functions of the FCC and of telecommunications agencies in the executive branch be strengthened.

CHAPTER III
Service Needs and Opportunities

SECTION 1: BUSINESS AIDS, REFERENCE SOURCES AND ENTERTAINMENT

The apparently disassociated areas of business aids, reference sources, and entertainment have one element in common -- the heavy reliance on telecommunications. Because of the increasing cost and inconvenience of travel and the relatively slow speed and rising cost of physical document transfer, this reliance is expected to continue and increase. Technological advances leading to reduction in constant-dollar cost for telecommunications services will further increase this reliance.

BUSINESS

One trend in today's urban life is the production of more information and services. Now that three-quarters of all Americans live in cities (in contrast to only two-fifths in the year 1900), it is not so surprising that about one-half of the total U. S. work force is employed in the service sector. 8/

The social and economic impacts of the shift from goods-producing to information-service industries in metropolitan areas require special attention to planning the future applications for telecommunications technologies. Such technologies may be examined from the point of view of either the supplier or the user. The committee chose to describe and assess the services available to the user, and further limited the scope of its review to the following: large building complexes, professional groups, consumers, banking and finance, transportation, and securities markets. In addition, potential services rather than existing services were given the major emphasis in this review.

Business Office Complexes

The social impact of unemployment in manufacturing in the large metropolitan areas, the migration of industries from the central business district to the suburbs or rural areas, coupled with problems of waste disposal, environmental pollution, health care, and energy have stimulated some regional planners to develop concepts on how to improve the business environment and opportunities within the city. One solution envisioned is the establishment of urban industrial parks.

The concept of an urban industrial park suggests new services offered on a shared basis to individual businesses within a complex of offices and industrial buildings. These new services might include: fire surveillance; alarm and emergency control; security surveillance; monitoring and control for individual building environments; external real-time environmental monitoring to meet community standards (air and water outfall quality); video conference center; information center; centralized dictation and word-processing center; 24-hour telephone answering, radio dispatch and message service; transportation scheduling and control; medical services; employee training; electronic mail center; electronic reference services and training institutions; and interconnections with other industrial and commercial centers. These integrated telecommunications, information, and related services, provided on a multi-user and cost-effective basis, could give small commercial/industrial tenants access to services heretofore available only to the larger establishments. Additional opportunities evolving from the industrial park concept, such as the recycling of waste material, might also become economical.

Development and Delivery of Commercial Services

In metropolitan areas, the large group of professionals -- including medical, scientific, and technical specialists, managers, proprietors, buyers, and government officials -- rely on economic, rapid communications for effective performance of functions. Their telecommunications requirements incorporate functions such as (1) a rapid method of intercorporate or interoffice document or mail transfer with minimum reformatting; (2) rapid access to current financial information about customers and suppliers with bank certification; (3) information on product and service sources, distributors, specifications, delivery, and prices; and (4) information on transportation facilities and schedules for accommodating personnel and materials.

The growing trend for small- and medium-sized professional businesses in the U. S. to retain overseas agents requires fast, efficient telecommunications. Thus far, little or no difficulty has been experienced in international data traffic interconnection, despite different equipment suppliers. No change is anticipated in the continuing capability to cope with international data traffic. In such commercial services there is room for considerable growth in the use of telecommunications to improve efficiency and reduce costs.

Consumer Information Services

Consumer purchases are often made with incomplete information. Often when making a new purchase, the consumer finds that technical data, quality, warranty, maintenance, and repair information are often unavailable in a timely and meaningful format. By contrast, manufacturers and service businesses have improved their market information by teleprocessing data derived at least in part from point-of-sale systems. This information has resulted in marked

improvement in the management of inventory and efficient personnel assignments. It has also led to acquiring more accurate data. In this connection, consider the case of the airlines which are able to spread the load on their reservation and information systems as a result of the knowledge of traffic being handled at various points and the ability to transfer calls between points.

Using the same point-of-sale and related information systems, an order clerk could obtain product information for a potential customer from a central data complex prior to purchase, so that both merchant and consumer could benefit from telecommunications technology.

Banking and Finance

The banking and financial community is of special interest to any study of urban telecommunications because it has its principal headquarters in metropolitan centers and has a demonstrated need for high volume telecommunications and rapid information transfer. Thus, at present, independent point-of-sale systems are being developed to carry out: 1) marketing, distribution, and inventory control functions; and 2) electronic funds tranfers. Because both services use similar types of terminals, a combination may prove economical for these two independently developing systems. Rather than discuss electronic funds transfer, a subject already being effectively addressed by others, 9/ this report will not go into detail other than to note that it is an area of interest and concern to urban area planners.

In addition to electronic funds transfer, a number of specialized information services such as Dow Jones International News Wire, and Commodity News Service have been developed for the banking and finance community. These services require interactive communication facilities to link together the geographically diverse financial centers.

An emerging application in the financial sector requiring a sophisticated telecommunication system is in the electronic securities market. The Securities and Exchange Commission (SEC) has recognized the need for, "an efficient and comprehensive communications linkage between market centers consisting of a real-time composite transaction reporting system and a composite quotation system displaying the bids and offers of all qualified market makers in listed securities." 10/ A number of key requirements for this system have been adopted, but others are still under consideration.

While existing technology appears to be capable of satisfying the requirements for a central market system, a comprehensive plan for a telecommunications system has not been agreed upon as of early 1977. Whether such a plan comes from industry or government, its development needs to be a high priority consideration in any national market system. (It should be noted that the SEC is conducting a study of a National Market System with the National Market Advisory Board.) 11/

Transportation Aids

A key application of telecommunications in transportation is electronic reservations systems. Typical system users are airlines, hotels, and car rental agencies.

Major airlines operate automated reservation systems in order to maintain maximum load factors on aircraft. Some systems also provide flight information and enter passenger reservations information for interline bookings, and may also accept reservations for tours, auto rentals, and hotels.

One difference between the reservations systems used by airlines and other travel and hotel reservation systems is the public's satisfaction with verbal confirmations in the former case and the preference for hard copy in the latter case, which tends to increase costs. The hotel and tour industry also experiences lower volumes, longer connect times and variations in individual system operating procedures, all of which contribute to relatively high costs per transaction. The effectiveness of travel and hotel reservations systems could be improved if information on vacancies, cancellations and other relevant transactions were more readily available from a central source.

REFERENCE SERVICES

Many of the service areas in metropolitan life -- commerce, health care, education, libraries, courts, and police protection -- have a need for information data bases. Although there are many types of data bases, they can be categorized as item search, content search, and multi-use systems.

Item search systems characteristically involve routine access to data bases where the information required is identifiable by the user. Typical applications in this category are stock quotations, reservations, and inventory systems.

Content search systems involve information retrieval where one searches without specifics as to the exact identification and format of the information. Into this category fall a number of commercially developed systems, such as the New York Times Information Service, and patent and legal search systems. In addition, a number of content search systems have been government-funded. The Smithsonian has a scientific data base; the Navy has an environmental data bank for all of its operations. Since such systems are expensive to create and operate unless they have a large number of subscribers, relatively few have been developed.

Multi-use systems involve access to and retrieval of information from data banks, as well as the capability to process data. Some multi-use systems are extensions of an item search system in which data once retrieved is then processed for some other application. As examples, the price of a security is used in determining the value of a stock portfolio, and facts on climate trends from the Smithsonian data bank are used to forecast crop production, say, in the Kansas wheat belt. A more complex example is typified by computer-aided instruction systems described in Section 3 of this chapter.

Information systems are typically characterized by widely dispersed users. Therefore, centralized data bases are economically advantageous when the existing public telephone network provides the basic communications link between the user and reference sources. The combination of teleprocessing networks with cable television (CATV)

is not expected to be widely used in the next five years, largely because CATV has not penetrated the business and governmental communities to any large extent.

Data base services are expected to grow at about an average annual rate of 15 percent for the next five years, as compared to other computer services growth of 25-30 percent. Furthermore, growth is expected to occur almost entirely in item search systems and their extension to multi-use systems as a result of their substitutability, at reduced costs, for existing methods of information handling. Only a few commercial applications, such as those just cited, have been developed because of the complexity and high cost of the systems. Many new data base applications will become economically attractive as intelligent input-output terminals improve and storage costs decrease. Such techniques as packet switching are expected to reduce long-distance transmission costs and create new opportunities. Local loop costs may be one technical factor limiting the development of these new applications. However, many have low duty cycles and now adequately use the switched telephone network.

ENTERTAINMENT

For more than a decade, there were those who predicted that direct satellite broadcast and CATV would revolutionize the entertainment industry. Substantial changes have occurred only recently. Communications satellite technology (with its comparative advantage of one-to-many broadband transmission), stablizing costs for home television terminals, decreasing costs for microprocessors, growing CATV networks, and small electronic cameras and video tape recorders for electronic news-gathering hold new promise for home entertainment.

Henceforth, consumers can expect advances in electronics to provide:

- increased variety in television programs, and
- add-on equipment to the basic television terminal.

Increased variety in programming is resulting from a number of factors. The Public Broadcasting Service (PBS) is planning a national video system using satellite transmission facilities. The planned system will allow local PBS programmers to choose from any one of three programs available at any time -- a 200 percent increase in choice. Pay television provided through CATV networks is becoming an influencial factor in the variety of home programming. It is predictable that more programming variety will lead to CATV's greater penetration in homes and vice versa. Finally, the interconnection of CATV networks may provide further impetus for growth. One study forecasts the growth of CATV subscribers from 18 percent of the households with television receivers in 1976 to 26 percent by 1980. 12/

The presence of a television terminal in most homes has fostered many concepts for additional use. Indeed, many proposals calling for the yet-to-be-invented universal home telecommunications terminal have centered on the television terminal. Several European

telecommunications authorities, including those in the U. K., Germany, and Sweden, are planning computer-based information systems utilizing the telephone network and the home television receiver. Among the successful add-on equipment to U. S. home television sets is electronic video games. The basic technology of these electronic games involves integrated circuits and microprocessors. With an expected market of more than $1 billion by 1980, many companies are marketing these products. Following the pocket calculator and digital watch markets, based on similar technologies, home video games are likely to become a dynamic and competitive industry. Systems have been developed for the recording of programs for playing on home sets, and for providing subtitles to bring news and information to the deaf.

The Potential for Integration

Paralleling its review of telecommunications applications, the committee considered the potential for integrating seemingly disparate services. The attached matrix (Table V) displays a number of technical and system characteristics for some of the applications listed in this section. This matrix is an example of the type of review that could be undertaken for all applications, using the format developed in Chapter II.

In the process of developing this matrix, the letter "V" was used to indicate that telecommunications facilities readily available were capable of satisfying the requirement. A page of footnotes follows the matrix.

A review of the completed matrix led the committee to conclude that the switched voice network, as it currently exists, can satisfy most of the technological requirements of the business aids and reference sources applications. The development and increased use of techniques such as packet switching will also create further opportunities for integration of these applications, but differing network requirements (mainly broadband) for entertainment and cultural applications indicate a lower potential for integration with the other areas.

TABLE V Method of Information Handling and Telecommunications

| | Mobility of Service | | | Daily Duration | | | | | | | Billing Parameter | | Bandwidth of Service | | | | | | | Privacy of Service | | | Service Direction | | | Terminal Type | | | | | | | | | | | | | | Multi-Purpose (e.g., Telecommunications Plus Answer) | | | Standards | | | Regulation | | | | System Type | | | | | | | | | | | | | |

FOOTNOTES TO TABLE V

1. Full Period was defined by the Panel as the need for a dedicated line.

2. Busy Hour Calling Rate is given per terminal.

3. Holding Time Per Call is given in total seconds.

4. Response Time Needed is given in total seconds.

5. Line Printer was not included in the Technology Panel's list under Terminal Type. The Panel defined this category as a high speed printer.

6. The Panel defined Sponsor as the owner and operator of the service offered.

7. Approximately 5% of these services would require full period service. 95% would not.

8. In all cases, V indicates that the service currently provided by the switched telephone network is acceptable.

9. U indicates that this is required by the user for satisfactory service.

10. Item Search Systems is a broad category which incorporates a variety of specific services. The Committee determined that one service, law enforcement, required mobility. Most item search systems do not require mobility.

11. 90% of these services require no privacy. 10% do.

12. Adequate service could be met by the voice network. Optional service would require 95%.

13. 90% of these services require no privacy. 10% do.

14. 90% of these services require no privacy. 10% do, e.g. electronic funds transfer.

15. NA (Not Applicable).

16. The Central Business Support Center is applicable to the small business. It incorporates word processing, WATS, telephone answering and dictation. The purpose is to free small businesses from the administrative service provision.

17. The terminal for Industrial Park Interconnect will require specialized terminals in addition to those listed.

18. Radio receiver would be required.

SECTION 2: GOVERNMENT ADMINISTRATION AND THE NATURAL ENVIRONMENT

During the next five-year period, communications technology will offer many opportunities in the administration of local governments and the monitoring of environmental conditions. Such opportunities are based upon better use of existing technology. As city government operations and environmental agencies adopt integrated management information systems, they will require still more sophisticated telecommunications systems. But these sophisticated systems are not likely to be as effective as they could be unless local management objectives, procedures, and disciplines are established and clearly defined.

The experiences of New York City, Los Angeles County, Baltimore, Maryland, and Fairfax County, Virginia, have been examined in this study. In addition, the committee relied on data gathered from its review of five cities -- Charlotte, North Carolina; Dayton, Ohio; Long Beach, California; Wichita Falls, Texas; and Reading, Pennsylvania -- taking part in a federally sponsored program to develop information systems for local governments. 13/

GOVERNMENT ADMINISTRATION

Government administrative communications include those services, systems, and facilities used in conducting day-to-day non-emergency government business. Typically, these administrative government communications applications include municipal information systems, utilities management, tax assessment, and billing.

Local governments currently use a wide variety of telecommunications systems and services, including the telephone network, radio paging, intercommunications systems, administrative radio systems, data communications networks, and cable television. Most uses are handled via the telephone network.

The communications needs of a sprawling urban county government present a definite challenge to an administrator whose job is to provide an efficient communications network at minimum cost. For example, a large number of government switchboard facilities may be located throughout a metropolitan area. Each switchboard provides "information service" and is responsible for determining to which one of the many departments the call should be connected. This problem becomes more complex when information is required from various levels

of government (city, county, state, and federal). Furthermore, the exact nature of the need and the source of information about it may be difficult to define precisely.

Table VI illustrates the large number of communications paths that are needed to handle the flow of information and services. Many options are available for designing systems to fit the various government entities in different parts of the nation. For example, Los Angeles County has developed a detailed communications plan that includes the communications requirements within the county and calls for the development of a communications organization and communications systems alternative model. 14/

Local governments require an increasing number of data communications circuits to tie together management information systems with the various users. CRT terminals to access information stored in computer data bases have been the fastest growing use of communications by local governments. Los Angeles County, to cite it again, has installed more than 800 CRT terminals during the last two years to access major data bases. The need for a common switched cost-effective data network becomes more evident as the number of uses for computer data communications continues to increase. As integrated management systems are built in the future, data networks and communications lines will continue growing. Attempts to build large centralized urban management systems have thus far been largely unsuccessful. 13/

As local governments try to improve their management efficiency, two issues need to be addressed:

(1) How to get more from diminishing resources, or at least maintain the status quo, and

(2) How to aggregate or regionalize common government services to gain maximum effectiveness and reduce duplication of effort.

The number of local government administrative uses for telecommunications is large and difficult to classify. One important reason is that telecommunications systems must reflect the management systems they support. In addition, the existence of wide variations in management processes by local governments makes it difficult to specify telecommunications opportunities.

The USAC study found that local governments generally had experienced great difficulty in implementing modern computer and data management techniques because of the inadequacy of local government administration systems. 13/ This conclusion also applies to the implementation of telecommunications systems. As local governments adopt improved management systems, they can further improve efficiency through more sophisticated telecommunications systems.

In government administration, it may be impractical to take full advantage of the telecommunications opportunities in advance of in-depth studies into the management processes that go on in civic administration. This is not to suggest that achievement of better results through telecommunications is not possible. It is. Indeed, a

Table VI

GOVERNMENT ADMINISTRATION

Fed. National	to Fed. Regional
Fed.	to State
Fed.	to Local
Fed. Regional	to Fed. National
Fed. Regional	to Fed. Regional
Fed. Regional	to State
Fed. Regional	to Local
State	to Fed. National
State	to Fed. Regional
State	to State
State	to Local
Local	to Fed. National
Local	to Fed. Regional
Local	to State
Local	to Local
Citizen	to Fed. National
Citizen	to Fed. Regional
Citizen	to State
Citizen	to Region
Citizen	to City
Citizen	to County
Citizen	to Village
Citizen	to Town
Citizen	to Service
Service	to Citizen

significant amount could be done now, but emphasis should first be given to the management process.

ENVIRONMENTAL MONITORING

In an environmental agency, communications is required with field personnel, polluting sources, news media, the public, and operational monitoring systems. One communications requirement is to respond to a citizen's urgent complaint of odors, smoke, or property damage. Based on the information received about the alleged pollution, a radio message is broadcast to a mobile field unit nearest the complainant.

The next step is to communicate with the polluting source. Thus, in the atmospheric monitoring system used by the Southern California Air Pollution Control District, a special coded transmission is activated by selected tones from the radio console when the air is contaminated to certain specified levels. Current information on air pollution forecasts, health advisories, episode notifications and terminations, and pollution levels are relayed to the public through the media and by direct and taped telephone messages.

Operational uses of communications for environmental monitoring include air, water, water utilities, solid waste and noise abatement (see Table VII, pages 42-43). For example, a number of air monitoring sensors continuously measure and record meteorological parameters and concentrations of air contaminants in the atmosphere. When a sensor detects a high contaminant level, an automatic alarm signal is transmitted via a communications network to the headquarters where a person can be dispatched to record and verify the reading. A more sophisticated system could transmit the sensor readings directly to a computer system for automatic monitoring and logging.

The list of environmental monitoring uses of telecommunications is growing. Priorities have not been established because environmental monitoring technology is undergoing rapid change. Improvements in sensor technology may be required for some monitoring applications. Improved regional cooperation between local governments would allow for the design of more optimal communications systems. Communications technology is generally considered to be adequate to meet near-term environmental requirements.

Thus, in government administration and environmental monitoring, several important trends have been observed. First, the public resistance to the high cost of government has continued to increase, and there is a definite need for improved efficiency in civic administration. Second, responsibility is increasingly shared among the levels of government as revenue sharing and new methods of financing have come into play. There is now, more than ever, a need for closer regional cooperation among governments for common approaches to government administration, environmental protection, transportation, and communications.

A third trend has been the rapid increase in the use of computer systems. While the majority of the installed government applications are financial accounting systems--i.e. utility billing and tax assessment--several cities and counties have attempted to develop

Table VII

OPERATIONAL COMMUNICATIONS

I. Environmental Monitoring

A. Air
Weather
Point Sources (Emissions)
Mobile Sources (Emissions)
Area Sources (Emissions)
Pollutant Concentrations (Ambient Quality)

- Gaseous
- Non-Gaseous

B. Water
Weather
Stream Flow
Surface Water Quantity/Quality
Ground Water Quantity/Quality
Discharge Quantity/Quality

- Point Source
- Non-Point Source

Emergency Episode (Toxic Spill, Etc.)

C. Water Utilities
Water Supply

- Raw Water Source Quantity/Quality
- Treatment Plant
  - Intake Quantity/Quality
  - Treatment Process Operations
  - Treated Water Quantity/Quality
  - Process Residual Disposal
- Distribution System Quantity/Pressure/Quality

Central Sewage Disposal

- Collection System Flows/Pollutant Concentrations

C. Central Sewage Disposal (continued)

- Treatment/Disposal System

  - Influent Quantity/Quality
  - Treatment Process Operations
  - Effluent Quantity/Quality
  - Receiving Water Impact
  - Process Residuals Disposal

Storm Sewer System

- Operation During Storm
- Flood Emergency
- Operation/Maintenance/Repair

D. Solid Waste
Collection System Control

- Dispatch Control

Disposal System Control

- Operations Control
- Environmental Monitoring

E. Noise
Fixed Source (Emissions)
Mobile Source (Emissions)

- Surface
- Aircraft

Occupational Environment (Ambient)
Community Environment (Ambient)

- Highway Corridor
- Airport Area
- Other

an integrated management information system, although only a few have operational systems that provide government leaders and decision makers with the information they really need each day to do their jobs. These trends taken together tend to suggest that pressure is mounting for improved telecommunications service in support of government administrations.

Therefore, it is recommended that consideration be given to the development of regionalized information systems to serve the mutual needs of overlapping governments. Federal agencies need to encourage through sponsorship and grant programs the design and use of information systems that would integrate local, state, and federal communications needs. If proper emphasis is given to the management process, the solutions to common communications problems could follow. Without such encouragement, city governments are likely to be the last to enjoy the fruits of the telecommunications revolution when, as a matter of social concern, they should be among the first.

A somewhat similar approach has been recommended in the report of the USAC study of the standardization of basic government functions and the sharing of computer applications in civic administration. 13/ The sharing of communications ideas, concepts, and proven products, among the various levels of government could be very beneficial.

SECTION 3: HEALTH, EDUCATION AND WELFARE

Because the areas of health, education, and welfare each encompass a broad range of activities, the committee limited its scope: in health the committee reviewed potential telecommunications applications in the delivery of health care; in education the committee examined a number of promising applications taken from a broad overview; and in welfare the committee relied on a limited case study of the Baltimore welfare situation.

HEALTH CARE

In 1975 the entire health care enterprise in the U.S. cost more than $118 billion, or approximately 8 percent of the gross national product. 15/ Total health care costs have risen at more than 10 percent annually in recent years. 16/

It is a truism that to be successful a service function must be a good match at its human interfaces. Telecommunications services for medical purposes must thus match a medical community with its inherent conservatism, its high degree of decentralization, and its reliance on the personal decisions of doctors, as it treats a highly variable entity -- the human being.

Access to Medical Care

One barrier to appropriate access to health care is the patient's reluctance to seek medical attention. There is evidence that even cardiac patients undergoing their second myocardial infraction may delay seeking help for unreasonably long periods. This has suggested to some that there are psychological pressures on the patient to deny an apparent illness and to hope, thereby, to avoid its consequences. One study 17/ found that of those patients who survived a cardiac attack, only 46 percent had called a physician within two hours of the onset of an attack. If this behavior is typical, then the patient's failure to call a physician may account for a large fraction of cardiac deaths. The point is that the ratio of patients who seek and need access to medical care to patients who fail to seek care, although they need it, may be far too low.

One alternative approach is to identify high-risk medical patients and call them for a periodic checkup or to provide them with alarms that automatically announce that care is required. One class of such patients are those known to be at risk from electrical death due to cardiac arrhythmias. Current research suggests, but has not yet proven, that high rates of a particular arrhythmia known as premature ventricular contractions may be precursors of electrical death if they occur at excessively high rates. Equipment is now under development (by Dr. Roger Mark at M.I.T., under an NIH grant) using belt-carried microprocessors with alarm signals to alert the patient to the occurence of such arrhythmias. Researchers contend that the alarm will alert such patients to seek care or alternatively, in the home, that the monitoring device could be automatically interrogated by polling devices of the kind proposed for checking fire and burglar alarms. Such detectors are only one of a class of instruments that might be developed.

Another important constituent of appropriate access to care is patient reassurance. It is conjectured that a significant proportion of all encounters with the nation's health care system serve primarily to reassure the patient. 18/ What role could telecommunications serve for such patients? In an institutionalized medical care system, one can envision a system (and one already exists at the Harvard Community Health Plan in Boston) 19/ in which the concerned patient calls the provider institution. The telephone call is answered by a trained provider who has computerized access to the complete medical record of the patient. Reassurance or specific medical advice can be given more safely with access to the patient's medical record. This telephone service would be provided around the clock to offer reassurance or to give advice on what actions to take. Furthermore, with such an institutionalized system it is possible to followup such calls to ensure that whatever condition that led to the inquiry had subsided or been treated.

Once the patient has moved to the site of health care delivery, the next most appropriate access might be to a non-physician or paramedic who would make a therapeutic decision when appropriate, or make the decision that the patient required more sophisticated medical treatment.

No measurements have yet been made of the reductions in clinical referrals that could result from such telecommunications consultations with a physician or paramedic. The most definitive experiment dealt with the contribution that television might make to such an encounter. Dr. Moore and his collaborators 20/ have shown in a controlled trial that television consultation between a nurse and physician on ambulatory cases takes 25 percent longer than a telephone consultation, but reduces by half the number of referrals to a physician.

While it is improbable that telecommunications will be able to help much in extending the physician's role in initial diagnosis, it may be able to help considerably in later followup monitoring and in watching for change. Once the patient's medical complaint has been diagnosed and the need for followup monitoring and treatment has been ascertained, the need for telecommunications bandwidth is sharply reduced, the communications periods are much shortened, and the patient

is much more willing to "submit" to remote monitoring, particularly if it is convenient. Such simple monitoring as taking a temperature, coupled with accurate but inexpensive memory and comparison, would go far to alert the individual, in private, when it might be worthwhile to visit a physician, and could provide the doctor with a relevant and timely case history. Whether the monitoring is done at home, at a local clinic, or by a dispensing machine would depend upon the relative cost-benefit ratios of the instruments, transportation, communications, data storage and retrieval, etc. Technology is bringing down the costs for each item differently. But, as transportation costs rise with the increase in energy costs, and data communications and memory/analysis costs decrease with each reduction in solid state electronics more widespread monitoring could become a reality.

In-Hospital Care

Professor K. White's survey 21/ shows that of 1,000 adults sampled in a given month, about 10 will be hospitalized. Although this means only 1 percent of the population is in the hospital at any one time, it also means about half of the health care dollars are spent in this way. Within the hospital much could be done about monitoring telecommunications.

With the growing use of computers as monitoring devices, it is possible for every bed to be wired with a standardized connection for a variety of instrumental needs, just as oxygen and vacuum lines are now installed in hospital rooms. Thus, cardiac monitoring of a larger proportion of hospital beds might be done more cheaply by a centralized system. Furthermore, because virtually every hospital room is now equipped with coaxial cable for television reception, the multiple use of the cable would make possible television surveillance of the patient, instrument monitoring by equipment such as the electro-cardiograph, intervention control (e.g., the raising and lowering of patient's beds from the nurses' stations), access to the patients' medical record from the bedside, physician entry of medical orders, and dietician inquiries about meals. This is one instance in which coaxial cable, already in place, may make additional communications services economic.

Physiological Instrumentation Data

The transmission and processing of data from instruments measuring nonphysiological phenomena are now very well developed technologies, advancing rapidly into "smart" instruments and distributed information processing. Some of the basic ideas of these technologies might be applied to physiological telecommunications. Distributed data bases could ease the problems of keeping instrument records where they can be used most effectively, helping to reduce human error, maintaining record privacy and avoiding misinterpretation or abuse. Such instruments could help the physician or nurse treat the patient through better displays, alarms, reminders, simple crosschecks, and even standard medical suggestions. Electrical data, such as that from an electro-cardiograph, can be sent to o[illegible] cations for further

analysis--a procedure that has been demonstrated to be both medically and financially effective. In doing this, error, response time, and costs per test have been reduced and the reliability of the diagnosis improved. Not the least of the advantages is that, with the number of cardiographic tests increasing faster than the available number of cardiographers, the new technology helps avoid saturation and additional costs.

At present, however, the transmission and processing of real time physiological data are available mainly in major medical facilities. Less expensive instruments and optical fiber communications might lead to more affordable bedside systems, especially in new hospitals and clinics, within three to five years.

The next most significant access problem is the followup of the ambulatory patient after the visit. In some illnesses there are concrete measures of outcome that can be objectively verified. In certain infections, for example, a satisfactory outcome can be verified by the inability to grow out the offending organism after treatment. Keeping track of such outcomes requires a followup system, including recalling and retesting the patient. This results in additional costs for the health care system. Unfortunately for a number of illnesses the symptomatic problems may disappear, so that the disease is hidden or undetected until it re-emerges in a more virulent and damaging form (i.e., hypertension, syphilis). In a country in which some 94 percent of the inhabitants have ready access to telephones, followup is at least possible in such cases if there were institutional or provider incentives.

Discharge from the hospital to home is a different form of access. Hospitalization is now so expensive that a real incentive exists to send patients home as soon as possible. There is a concern about medical efficacy when patients are placed at some potential medical risk by early discharge from the hospital unless an assured technique can be provided to monitor the condition of patients. Post-hospitalization monitoring at home is an area in which telecommunications might indeed be useful. Reference was made earlier to the premature ventricular contractions monitor for patients with cardiac risk, along with pulse rate monitoring. Similar monitors might be used for other conditions. Post-surgical patients might have their temperatures monitored regularly (on-call), without disclosing to the patient any anxiety-producing readings, through remote access to the temperature sensor. Simple-minded respiration monitors can be envisioned. With little ingenuity one can even envision monitoring certain blood chemistries through either finger-sticks for blood samples or other schemes for extracting blood sera painlessly.

Such techniques are aimed at the care of medical conditions that are fairly common and whose treatment is relatively standard. There are a number of conditions for which research is still intensive (e.g., cancer chemotherapy). For some of these conditions there may, under the proper circumstances, be value in the sharing of physician experiences with different processes of care and their current success. This would involve the exchange of data between computers over networks akin to the ARPA network. There are no telecommunications barriers to the establishment of such networks--although there are substantial

organizational and sociological barriers. Exchanges of this kind presuppose widespread agreement upon data sets, including the definition of terms, the accuracy of data collected, and the number of data points. Such agreements on data do not now commonly exist in medicine.

Medical Care Delivery in Other Settings

There are real opportunities for physician extenders provided with minimal technological tools and telecommunications access to a physician from nursing homes, jails, and mental institutions. Programs are underway which demonstrate the feasibility of monitoring health in such settings. 22/ The incremental value of more sophisticated monitoring requires study, particularly when a number of patients at risk are gathered at a single geographic site.

EDUCATION

Education is another of the nation's largest enterprises, employing over 3 million people and consuming nearly 8 percent of the gross national product. Because the education process is primarily a state and local matter, it is characterized by its decentralization. To underscore the importance of education in metropolitan areas, 39 percent of the combined budgets of state and local governments were spent on education in 1971-1972. 23/

In the past two or three decades major educational telecommunications services have been implemented, including 1) public broadcasting, 2) instructional television, 3) computer-assisted instruction, 4) computer resource sharing, and 5) information resource sharing.

Some of the more prominent applications of telecommunications to education are:

- Broadcasting--two programs that exemplify the potential of this medium are "Sesame Street" and "The Electric Company". These programs reach large audiences at pre-school and elementary education levels, both in homes and schools.

- Computer-Assisted Instruction--two major CAI systems are presently under test and evaluation: the PLATO (Programmed Logic for Automatic Teaching Operation) system at the University of Illinois uses a large centralized computer with many remote student terminals incorporating a plasma display and keyboard 24/, and the TICCIT (Time-shared, Interactive Computer-Controlled Information Television) system developed by the MITRE Corporation utilizes computer-generated alphanumerics and graphics as well as supplementary videotapes and audio presented to a student terminal consisting of a color television set and a typewriter-like keyboard. 25/ The PLATO system requires only telephone link communications and has been expanded

beyond the academic boundary, with financing by licensed commercial interests taking place outside the original academic base. The TICCIT system requires a broadband communications system, e.g. cable television. Further experimentation and evaluation is required with a broader application of CAI in appropriate cases.

- Videotapes--videotapes of classroom situations, when played to small groups with an informed tutor have resulted in student achievement on quizzes equal to that of conventional teaching methods. 26/ Videotapes reduce the cost of lecture preparation and enable a high degree of learner participation.

Table VIII, page 51, identifies and evaluates those telecommunications services that support various educational subsectors in metropolitan areas. The table is based in part upon results of previous studies 27/ and has been developed further by the committee. The right-hand column reflects the committee's analysis of current applications.

In reviewing such telecommunications applications, the committee found that it is not at all clear that telecommunications is a cost-effective and acceptable means for improving the educational process. Among the factors that add complexities to the pure technical utility of telecommunications in education are:

- Financial--school tax bond issues have become more difficult to pass, and population shifts within the metropolitan areas have meant decreased financial support in inner-city areas with diminishing enrollments.

- Cost-benefit tradeoff--not enough is known about educational production functions to determine the effectiveness of telecommunications vis-a-vis the current method.

- Labor--education is extremely labor-intensive, the largest component of the cost of education being salaries estimated to range from 70 to 90 percent. Change in the process of formal education may occur slowly because of tenure agreements, labor organizations, and the need to achieve teacher acceptance of new methods.

The picture that emerges from this analysis is that of a large decentralized educational enterprise struggling with day-to-day problems of funding and decreasing enrollments. For telecommunications technology to have widespread impact on urban education, some necessary but not sufficient conditions are that:

- The technology be inexpensive and/or that there be a long-term commitment of resources, and

TABLE VIII Telecommunications Services for Metropolitan Education

Sub-Sector	Goals	Telecommunication Services
Early childhood education	Motivation, good citizenship, some cognitive and affective skills development	Current public TV offerings have had impact. Need to assure continuity in public TV offerings and development (Multi-year funding).
Elementary and secondary education	Achievement in the three R's. Improve quality	Some public TV impact. Room for expanded activity by CPB/PBS. CAI and CMI.*
Higher education	Expand access; share resources	"Open University" use of TV. Computer and information resources sharing. CAI, electronic blackboard, ITFS,* videotapes.
Vocational/technical education; career education	Make citizens employable; teach job skills; expand career horizons	Small-scale applications (videotapes) most useful for specific vocational skills. Broader "career education" concept has been focus of educational satellite demonstrations. Some use of computerized vocational guidance systems.
Education for the handicapped	To aid in developing potential; open up career options; make transition to self-reliance	Specialized technologies needed for specific handicaps. Captioned TV for the hard-of-hearing now coming into wide-spread use. Other developments needed: CAI for learning disabilities; optical magnifications for partially sighted, etc.
Adult basic education	Teach functional literacy and coping skills; high school equivalency	Public TV is promising. Some GED* programs now being carried.
Education for culturally diverse groups	Many of the same goals as in other categories but with particular emphasis on meeting unique needs of Black Americans; American Indians; Migrants; Spanish-speaking Americans	Many federal programs for educational technology development have been supported through programs for "disadvantaged." Cable, videotapes, CAI, public TV, satellites are all very important here. Key here is not the technology but in getting participation in planning and implementation by affected groups.
Education for the aged and institutionalized (nursing homes, prisons)	Supply retirement needs; maintain productivity (aged), chronic care (nursing homes) rehabilitation, job skills (prisons)	Generally neglected areas. Public TV programming could help. Also outreach from community colleges.
Continuing Professional Education	Maintain Competence, Update and Upgrade Skills, Certification and Licensure	Considerable Use of ITFS, Videotapes. Focus of Satellite Demonstration Efforts. User financial base fairly strong in some professions.

*CPB-Corporation for Public Broadcasting; PBS-Public Broadcasting Service; CAI-Computer-Assisted-Instruction; CMI-Computer-Managed-Instruction; ITFS-Instructional Television Fixed Service; GED-General Education Development.

- The cost and effectiveness of telecommunications in improving education be more clearly established.

In sum, the committee found that while technology and telecommunications have been used in education in a variety of ways, it is not clear that these are cost-effective or acceptable to the concerned groups--parents, teachers, school boards, and students --interacting in the education process.

WELFARE

The city of Baltimore served as a case study for welfare problems and opportunities that currently face many U.S. cities. With a population of about 900,000, Baltimore has some 100,000 active welfare recipients at any given time. Welfare is provided by a fragmented system in which several services deal separately with the same population. An integrated data base has not been organized to serve the welfare process. Furthermore, without tangible evidence with which to identify successful programs, Baltimore has no long-range plan for the development of human services comparable to its plan to modernize its physical facilities.

In order to analyze and evaluate the existing welfare programs for effectiveness, Baltimore has now instituted a Human Resources Reporting System to catalog the services, to record the number of persons served, and to compile the corresponding costs. Establishment of such a citywide coordinated data base distributed by a telecommunications network could improve efficiency of city welfare programs by:

- Reducing response time to the needy;
- Reducing requirements for overhead administrative personnel;
- Reporting promptly on disbursements;
- Possibly permitting some integration with education and health services.

Adequate provision for privacy is an important consideration in the design of such a data exchange network.

SECTION 4: EMERGENCY AND MOBILE SERVICES

This section discusses the uses of telecommunications to improve emergency services such as fire, police, and ambulance; and transportation operations, including automatic vehicle monitoring and computer-controlled traffic lights. By their nature, these services rely heavily on mobile communications for quick access and response time.

EMERGENCY SERVICES

The operational communications systems used in the provision of emergency services fall into four functional categories: input, coordination, dispatch, and control. Input involves the victim (or someone acting on behalf of the victim) establishing initial contact with some official who is in a position to initiate a response, and providing that official, either by voice or automatic signal, the location, scope, and type of emergency. The coordination function includes monitoring the status of all units so that information concerning availability is kept current. The input message is communicated to a dispatcher who has access to information or the availability of fire-fighting apparatus, police cars, or ambulances, and can call the appropriate units into action. Finally, the control function includes all contact between the dispatched units and their respective base stations to ensure that the emergency is met.

The implementation of the emergency telephone number "911" and such devices as fire alarm pull boxes are well established and continue to develop at an orderly pace. However, the universal use of the "911" number may require federal and state laws together with financial assistance. The bandwidth requirements for these applications are modest, ranging from the low-Hertz region (for pull boxes) to voice frequency.

A 1971 National Academy of Engineering study entitled, "Communications Technology for Urban Improvement" 28/ recommended that local governments implement automatic location identification (ALI) in conjunction with the "911" universal emergency telephone number. The Law Enforcement Assistance Administration (LEAA) is funding a demonstration of selective routing, automated number identification, and automated location identification. In this Alameda County,

California demonstration system, emergency calls from a problem area are automatically routed to the nearest of 16 public safety answering posts throughout the county.

The coordination function is basically one of status monitoring. Traditionally, coordination has been handled by manual input to display boards visible to the dispatcher. However, computer-aided dispatch systems are being installed in many cities with various degrees of sophistication. 29/ In a typical situation, operators take incoming calls and enter requests for service on a cathode-ray tube (CRT) terminal. Each call is automatically assigned an incident number, priority and time of day, and is then transferred to the dispatcher's console for assignment to a response vehicle.

While automatic computer dispatching is technically possible, most emergency units feel that human judgment is an important element in the system. Even so, the projects proposed for Dallas and New Orleans would bypass human dispatchers and assign complaints directly to specific vehicles. For the immediate future, however, the dispatch function is a low data rate system in the voice range with data rates up to 4800 bits per second. Circuits to mobile units normally based at fixed locations (fire and ambulance) are generally by dedicated lines, while police dispatching is by radio. Once a vehicle is in motion, communication is by radio.

The control function begins when the vehicle is on the way. During the initial dispatch, the flow of information is generally from the dispatcher (or computer) to the unit--what happened, where, special instructions covering unusual hazards, etc. Once on the scene, the flow of information becomes two way as reports are relayed back to the dispatcher by the emergency unit. Some emergency medical vehicles are equipped with sensors and telemetry facilities for sending vital statistics to a medical center. These use low data rate circuits (35 to 120 Hz), but, because of the need for high reliability and continuous transmission, are usually carried on radio frequencies provided by the Emergency Medical Radio Service (EMRS).

Most of the functions described above are handled by a combined emergency system. Indeed, centralized dispatching is being achieved at present to a fairly large extent. In 1975 the Associated Public Safety Communication Officers found that:

> A higher percentage (51 percent) of the centralized dispatching centers serve the total public safety emergency service including law enforcement, fire and emergency medical service than do dispatch centers serving a single law enforcement agency (19 percent). Overall, however, less than one-fourth of the dispatching centers are part of a total public-safety system. There are also a number of computer-assisted dispatching systems in operation and in planning stages. 30/

This study also noted that 27 computer-aided dispatching systems were in operation with approximately 60 more in the planning stage. Thus, the trend is in the direction of increased centralization and automation of dispatch facilities.

Automatic Vehicle Monitoring

Automatic vehicle monitoring (AVM) systems relate both to emergency services and transportation. The coordination function of an emergency dispatch requires a continually updated status indication of all emergency vehicles. This is particularly important in the law-enforcement field where the vehicles in service are continually on the move.

To date, practically all location reporting is limited to voice: "Car 54--Where are you?" AVM systems have been developed which are capable of locating vehicles without voice connection. This capability adds greater flexibility by enabling unattended vehicles to be located. There are no firm specifications for an AVM system satisfying the requirements of the emergency services, though some are in the developmental state.

AVM systems used for land transportation systems differ in concept from those for emergency services. Public transport vehicles generally traverse predetermined routes and can use location signalling to or from active "signposts"--that is, mounted equipment along the route with dead reckoning between posts. Certain people-mover systems may require more sophisticated and costly AVM systems.

Two vehicle-location systems are currently in use in the U.S. The St. Louis police use a dead-reckoning system in which odometer and compass information are combined to signal a current location. Chicago has a bus location system using the "signpost" technique, which updates the position periodically and relies on dead reckoning between posts.

The U.S. Department of Transportation is conducting an AVM demonstration project in Philadelphia. The objective is to conduct a "fly-off" between four contractors for a vehicle location system. The winner will implement a full-scale demonstration in Los Angeles. This system will include not only vehicle location, but automatic vehicle monitoring.

The Federal Communications Commission has recognized the developmental nature of AVM systems and has authorized the use on an interim basis of any one of four FM types of emission or one-pulse type systems. 31/ Wide band pulse systems (8 MHz bandwidth) and other wide-band systems (1 MHz) are allowed in the 900 MHz region, while narrow-band systems (25 kHz maximum) may operate on base-mobile frequencies in the low and high VHF bands and in the low UHF (450,512 MHz). This will enable the development of AVM systems tailored to the special needs of particular services.

TRANSPORTATION

The medium of telecommunications is broadly used in one form or another by various modes of transportation to (a) establish the relationships between vehicles of the same or different modes, (b) determine the geographical environment, (c) establish the location relative to fixed locations such as departure and control points and arrival destinations, and (d) convey the variables that define the state of the system.

A number of telecommunications-transportation related trials are planned or under way. Computer controlled traffic light systems have been tested in a number of urban communities. Many of these are now being abandoned, however, because of high costs. Some local governments have installed pole-mounted radios, hardwired voice telephones, or emergency pushbuttons along interstate highways for motorists in need of fire, police, ambulance, or repair assistance. The DOT also has funded the development of a safety and emergency system for the motorist who is unable to leave his vehicle. Needless to say, CB radios, proliferating ubiquitously, appear to be serving this purpose.

Another DOT project aims to provide highway advice to motorists by car radio. The motorist needs to tune the car receiver to one or the other end of the dial, depending on which direction the car is travelling, to receive such advisory information. The FCC is studying the use of 530 kHz at the low end of the band and both 1606 and 1612 kHz at the high end for such an advisory system.

Future Considerations

During the course of this review of emergency and mobile services, some promising concepts were identified:

- The ability of emergency vehicles to change traffic lights, when approached, to clear the route
- A means of alerting automobile drivers of approaching emergency vehicles (sirens and flashing lights lose effectiveness when competing with air conditioning and/or stereo hi-fi's)
- A means of alerting drivers to railroad grade crossings in use
- An integration between centralized traffic monitoring signal-light control systems, AVM, and emergency vehicle dispatching to select the most expedient routes for such vehicles
- The integration of emergency service communications with other vehicles such as taxis, buses, and delivery vehicles by means of cellular and trunked mobile systems

Such concepts require further development, testing, and evaluation to determine their potential benefit to metropolitan areas.

SECTION 5: CITIZEN SAFETY

Today, one out of every sixteen people living in metropolitan areas is the victim of some criminal act every year. The total number of crimes committed against people rose from 1,194 per 100,000 persons in 1962 to 2,830 per 100,000 persons in 1972--an increase of 240 percent. Not only has the crime rate risen every year for the past decade or two, but it has been increasing at a significantly faster rate in cities than in rural areas. A total of 3,413 crimes were committed per 100,000 people in Standard Metropolitan Statistical Areas (SMSAs) in 1972 against only 1,084 per 100,000 people in rural areas. Worse yet, the number of violent crimes totaled 492 per 100,000 in cities as against 144 per 100,000 in rural areas--nearly 3 1/2 times as great.32/

The safety of the individual citizen is dependent on the effectiveness of public systems created to deter and combat crime, to detect and extinguish fires, and to deliver emergency medical service; on the effectiveness with which the citizen can gain access to these systems, and, for crime prevention particularly, on how efficient these systems and the citizen's access to them are generally perceived. Telecommunications plays an important role in this.

Applications of telecommunications to achieve more effective police, fire, and medical systems have been discussed previously. Telecommunications to facilitate an individual's access to emergency systems includes the Dial 911 Program now being implemented, but available only where telephones are readily at hand. Citizens in automobiles equipped with CB radios are often able to call to emergency systems through a third party. Telecommunications systems now provide most of the access by citizens to emergency systems and if rapid, and perhaps automatic, access is to be further extended to individuals who are isolated and vulnerable, it will probably be by some telecommunications method.

The public perception of the efficiency of police and protective systems and of citizen's ability to access them is an important element in crime deterrence. This perception will be formed largely by another telecommunications application--broadcasting.

As a way to improve an individual's sense of personal safety, it might also be possible to create a Personal Emergency Service (PES) similar to the Dial 911 service to assist citizens in need of help or information on transportation and housing. When combined with an

automatic vehicle location system, a PES could pinpoint the location of the personal emergency and might be activated automatically.

To the extent that present crime deterrence methods are inadequate, new methods and technologies need to be examined in an effort to provide the individual citizen with increased personal safety while maintaining traditional civil liberties. Beyond the applications already discussed, could telecommunications technology contribute toward treating the roots of crime as well as its symptoms?

Community and neighborhood relationships with proper adult leadership can be extremely important in providing a viable means for attracting youth to gainful activities prior to the point where despair turns into crime.

One approach that involves telecommunications might be the development of Community Communications Centers to house a variety of cultural and educational activities, to provid· a forum for the debate of community issues, and to provide telecommunications facilities for the dissemination of information about recreation, entertainment, transportation, and, indeed, all public services. Such a center, equipped with cable access and video equipment, would make it possible for adults and children to work together on common projects in the performing arts, hobbies, crafts, and games. Telecommunications technology could assist a neighborhood to express itself and to create a sense of community within itself and with other neighborhoods.

CHAPTER IV

Opportunities for Further Study

During the course of its work the committee perceived the need for additional study in two broad areas:

1. Projection of telecommunications technology to become available in the 1980-1990 time frame. This effort would include:

   a. Examination of the need for and solutions to combining wideband and narrowband switching and network techniques capable of handling digital as well as analog transmissions.

   b. Examination of the need for and the potential impact of a low-cost switched digital network to serve a large number of users not adaptable to private networks.

2. Assessment of the potential impact of future telecommunications developments on urban problems and operations.

In undertaking the first task, the committee recognizes that the development of a long-range forecast is difficult and involves subjective assessments of current technological trends. However, developments in telecommunications continue at an extraordinary rate and in directions that can be assessed. Knowledge of trends for future technologies will aid present planners in addressing their problems and enable the incorporation of these new developments in a timely manner.

The second area for further study follows naturally from the first. Assessment of technological impact will require assumptions about the cities, their structure and role 10 to 15 years hence. Once again, assessment of the potential impact of the trends for future technologies will better prepare urban planners to meet their problems.

In addition to these broad areas, a number of specific problems related to this study would benefit from additional study:

- Examination of the wide spectrum of applications possible for electronic funds transfer and identification of the factors that may impede their development. This is an

issue of such size, complexity, and impact that separate studies may be required to examine all aspects.

- Determination of future possibilities of capitalizing on telecommunications technology to conserve energy.

- Determination and investigation of possible telecommunications systems to deter and prevent crime.

- Examination of the possible applications of improved mobile communication systems to increase the efficiency of such emergency services as police, fire, and ambulance.

- Definition of the types of interactive CATV services likely to develop in the 1980-1990 period and the needs for privacy and security safeguards in such a system.

- Evaluation of pilot experiments conducted in the public sector in a manner similar to the study conducted by the Committee on Telecommunications Urban Information Systems Interagency Committee (USAC) Support Panel of the Committee on Telecommunications.

- Implementation of pilot projects to determine the cost-effectiveness of telecommunications potentials in an urban environment.

- Review of certain governmental operational systems in a typical metropolitan area--an area in which federal, state, county, city, and borough jurisdictions increasingly intermesh, with emphasis given to the potential of significant cost savings through the use of telecommunications, coupled with system resource integration. Such a study should parallel the interests of federal agencies and departments in their relationships to metropolitan areas.

ADDENDUM
Ten Basic Issues

Introduction

The following ten issues were enunciated by the federal sponsors and agreed to by the committee for special attention in this study. The issues have been grouped by relationships to the extent possible. The list of issues is not meant to imply any ranking of priority.

ISSUE 1

What new communication demands that cannot be satisfied by the existing service categories are expected to develop in metropolitan areas?

Discussion

To respond to this issue requires an understanding of the process by which demands are analyzed and translated into products or services. The telecommunications industry has devoted major efforts toward anticipating new communications demands. This is only one of the steps involved in the complex process of developing new services and facilities to meet new demands. The expression of a desire for a certain capability does not ensure that it will be satisfied. Among the factors that must be considered in approving or disapproving the R & D for a new product or service are the following: technological feasibility, alternative systems concepts to meet anticipated demands, market forecasts for a range of prices, economic feasibility, and the perception by the user that a service is required. Even then such factors as lack of adequate funding or organizational discontinuity (such as found in local governments where the emphasis is on short-term rather than long-term considerations) may deter development. For its analysis the committee categorized new communications demands into 1) general communications demands; 2) new services that are not now available, but are anticipated by 1980; and 3) new services that are identified, but are not expected to be significant offerings by 1980.

In the first category the committee found that, in general, present communications capabilities adequately satisfy most demands that are expected to develop in metropolitan areas, with three possible exceptions. First, there may be demands for privacy and security in telecommunications that are not available for the existing service categories. Such demands are brought about by the need for individual privacy and the protection of resources handled by the various metro services (such as financial). Second, increased requirements for video transmissions to decentralized points may require the development of broadband capabilities in the local loop (from central office to individual subscribers) at reasonable prices. Third, certain demands may develop where the cost-effectiveness of utilizing telecommunications technology is not clear. One example is the need for low-cost terminal devices capable of monitoring, processing, and transmitting the status of patients to centralized points, either from the home or within the hospital.

In the second category the following services are now being introduced, or are anticipated by 1980: cost-effective alarm systems; economical polled transaction services; new switched voice services (e.g. message storage, improved audio conferencing); new common user data services (e.g. store and forward and packet switched systems which offer a variety of bit and error rates); video conferencing services, and widespread, economical mobile commercial services. This listing represents the type of services that will be implemented in the near future. A complete, detailed review is impractical because companies announce new products, new features, and new services almost every day.

In the third category -- services that can be met with existing telecommunications technology, but are not expected to develop into significant offerings between now and 1980 -- factors other than the expression of mere desire are involved. To the extent that the committee has been able to weigh such factors, the following demands are not expected to be met by the existing service categories: the provision of braille computer terminals for library services; the ability of emergency vehicles to change traffic lights as they are approached; integration between centralized traffic monitoring and signal light control systems; advanced automatic vehicle monitoring and emergency vehicle dispatching in order to select the most expeditious routing of such vehicles; advanced methods of applying telecommunications to deter crime; centralized welfare data bases that are effectively maintained and readily accessible; and the development of special terminals for non-hospital monitoring of patients. Once again, other factors may change the perception and need of these services by business and government and, therefore, alter the course of their development.

ISSUE 2

What federal or local government policies, facilities, and programs would stimulate telecommunications support to the disadvantaged, sick, or undereducated populations?

Discussion

Benefits to the disadvantaged, sick, and undereducated can be increased by a variety of applications of telecommunications, if one considers only technological possibilities and not the related costs. However, since health, education, and welfare costs comprise one-fourth of the GNP and severe pressures exist to restrain spending, the question is interpreted to be, "What programs would stimulate telecommunication support on a cost-effective basis?".

Telecommunications provides a principal medium for public information about appropriate health care measures to prevent sickness. Radio and TV can provide general information; telephone services can provide responses to individual questions. In the hospital, telecommunications can facilitate efficient service through both voice and data communications. For telecommunications in the hospital, conceptual options need to be identified and explored, and costs and standards need to be developed. Studies need to be initiated under federal programs to identify these options and develop appropriate costs and performance standards.

The complex, decentralized, and diverse nature of education and the number of people and groups involved are factors complicating the data review process in education. Emphasis needs to be given to the development of more complete data, particularly related to the cost-effective performance of the many components involved in education. This will allow the determination and evaluation of specific incentives to increase cost-effective performance. One application directly related to telecommunications in the educational field is computer-assisted instruction (CAI). Two major pilot CAI systems, PLATO and TICCIT, are already established and are currently being evaluated. Evaluation is needed of the performance and effectiveness of these systems compared with other commercial CAI systems and with traditional teacher-assisted instruction.

The welfare management system in metropolitan areas involves one population, but services are sometimes provided independently of one another. This fragmentation, which is typical of the welfare system, would be improved significantly by a data management system that utilizes an integrated (possibly distributed) data base. It is recognized that the establishment of such a data base requires the resolution of the potentially conflicting goals of individual privacy and of maximum system effectiveness.

A sufficient and secure base of research support for telecommunications needs to be sustained, even though emphasis on cost-minimization is clearly necessary. Innovations in telecommunications

need to be stimulated in the areas of education, health, and welfare. Measurements of the effectiveness of applications are needed. Objective data need to be gathered on which to base decisions on broader uses. Such developments require sufficient support for research.

ISSUE 3

How can communications services be developed and/or be made acceptable that will result in the savings of significant energy and/or time by replacing face-to-face meetings or the physical transfer of information media?

Discussion

Interest in substituting telecommunications for travel has become a more immediate concern because of the national policy to reduce energy consumption. The subject has already received a good deal of study. However, further study, tests, and demonstration are required to better understand which situations cause group interaction via telecommunications to approach the usefulness of face-to-face meetings. The limited experience to date offers evidence that audio teleconferencing is less costly and approaches the effectiveness of face-to-face meetings when the participants are well acquainted and are dealing with a subject well known to them.

The National Aeronautics and Space Administration (NASA) evaluation in 1975 of an in-house audio-facsimile teleconferencing network, using 34 terminals throughout the country, showed promising results. NASA documented savings of about 10 percent in its travel costs for the one-year experiment and estimated that this saving can be increased to 15-20 percent. 33/

Teleconferencing systems vary in sophistication and cost, ranging from a simple telephone call to elaborate facilities utilizing such aids as video, facsimile, and computer-controlled graphics. Video teleconferencing has been perceived as the superior means, but recent studies have indicated the contrary. Indeed, audio teleconferencing, under certain conditions, offers considerable advantages other than cost. Assuming that individuals are acquainted with one another and that face-to-face meetings take place, audio conferencing is a satisfactory way to conduct many meetings. 34/

Other media, such as computer teleconferencing and computer mail systems, need consideration and more systematic investigation. One example is the experimental computer-mediated teleconferencing project, called Project PLANET (Planning Network), operated by the Institute for the Future, Menlo Park, California, which is funded by the National Science Foundation. For all such approaches, improvement of the cost/performance tradeoff is the key to greater utilization of teleconferencing, and as a result, energy savings.

Lower cost telecommunications services, such as high resolution high-speed facsimile, may tilt the cost-benefit equation further toward the teleconferencing approach. Bandwidth compression techniques for TV would also enhance it as a more useful medium. Other means of using telecommunications technology in order to conserve energy need examination. These include (1) remote environmental readings and (2) remote control of appliances and space heating/cooling systems in residential buildings and business offices to lessen peak loads on the electrical generation systems.

ISSUE 4

What services, other than switched voice, could be accommodated by the common carriers, considering the full capability of telephone facilities to provide services in partnership with other facilities?

Discussion

From the point of view of technology, most services, with the major exception of television, could use the basic facilities of the present telephone network or reasonable extensions of it. However, because of regulatory constraints and economic considerations, other carriers or private facilities may be more attractive. Joint or shared responsibility for service by two or more systems requires some compatibility. In general, the necessary interoperability between systems is possible, and when available, permits the selection of the most cost-effective solution to a particular problem.

The telephone network is already used, with varying degrees of utility, for a wide variety of other purposes such as low and medium speed data transmission and hard-copy record service. The same transmission facilities, without switching, are used for private line service of all kinds. Examples include voice private line, high speed data, broadcast tie lines, and control and alarm circuits. When equipped with specialized switching equipment, these transmission facilities can be used for a wide range of services, some of which require bandwidths that exceed the capabilities of most telephone switches.

ISSUE 5

Might the cable TV plant carry services now carried by the telephone plant, such as:

Private Line Services
Communication of data over a limited network (narrow and broadband)
Facsimile?

Might a cooperative approach using both telephone and cable TV plants be desirable for these services or for others?

Discussion

The answer to the first question is a conditional yes. The services now carried by telephone plants and those carried by cable are ones whose functional requirements fit naturally to the operating characteristics of the respective systems. These services fall, more or less, into place without any forced fit.

Technically, it is possible to adapt many of the existing services to the other media by extraordinary measures. However, it is doubtful that it would be feasible for most of the services now being carried because of a number of social and economic factors that influence these operations.

New services not yet implemented will also fall naturally into one category or the other, depending upon the requirements. These requirements are developing only now, and it is not yet clear whether broadband cable, telephone plant, or other facilities such as mobile communications will provide the optimal service.

There are many distinctions between telephone and broadband cable systems. The basic distinction is that the telephone plant is a point-to-point switched common user service and the broadband cable plant is a non-switched distribution system. (Upstream is a collection process, but distribution is used here in a broad generic sense.)

It is true that, in telephone practices, there are private line and leased dedicated services; and in cable, there are such techniques as addressable taps. But, even in these overlapping areas, there are sufficient distinctions. These stem from the differences in the requirements for a point-to-point common user, multi-function network and a one-to-many, specific function network. Accordingly, services not now being actively implemented may be realistically allotted. As the demands appear, these distinctions will become more visible.

Turning to the second question of Issue 5, interaction between cable systems and other telecommunications media is already occurring. Hybrid systems for implementing interactive functions in which the broadband cable is used for downstream distribution, as well as the TV set for readout and the Touch-Tone telephone for the interactive keyboard, are performing satisfactorily. While the economies of such

a system are not yet proven, this looks encouraging. The approach is attractive when the upstream demand is relatively low. It capitalizes to the fullest extent on existing equipment.

When the upstream demand is greater, another variation of this is applicable. Here a leased telephone pair connects the output of the last amplifier in a cable system to a central processing plant. This approach provides direct connection of each leased pair to approximately 30 subscriber taps. For still greater upstream demands, it would be more feasible to install the upstream capacity within the cable system.

These cooperative approaches may make the initial step into interactive functions economically more attractive than the provision of this interactive capability by CATV facilities alone.

In relation to urban-rural communications, it is interesting to note the widespread use of microwave links to interconnect cable systems. Microwave is also used as a component of a single cable system for super or express trunk runs where the use of cable is difficult or expensive. Furthermore, extensive use of communications satellites is planned in the immediate future to provide nationwide distribution of such specialized programming as first-run movies and sports events for distribution by cable systems. In June 1976 this service was being provided through a system of 45 receive-only satellite earth stations owned by the cable companies.

ISSUE 6

Are there technical safeguards to individual privacy in an environment of widespread interactive cable TV; and is it feasible to offer a range of privacy/security at a range of prices?

Discussion

It is difficult to answer this question because the services being developed for two-way cable TV have not yet coalesced into a readily definable offering and the phrase "interactive cable TV" is too broad and unspecific.

Beyond this, once such services are considered for inclusion, there needs to be additional determination as to the levels of privacy and security that would be required. For services provided by CATV, as with any transmission media, the public perception of the adequacy of privacy protection will be based on a complex combination of legal, regulatory, policy, technical, educational, and psychological factors. Generally speaking, developments in integrated electronics and microprocessors offer a reasonable degree of confidence that adequate technical solutions can be found--though an absolutely secure system is unlikely. Relating privacy and security needs and potential technical responses to those interactive services considered most likely to be marketable is a multi-dimensioned task that could be significant in the future of metropolitan telecommunications. The committee suggests that,

first, efforts should go toward the clarification and classification of interactive services and their potential privacy and/or security demands. The privacy and security features must then be incorporated as an integral part of the overall system design.

ISSUE 7

Are reception and transmission in metropolitan areas from and to satellites technically important to:

- *Common Carrier Services*
- *Specialized Carrier Services*
- *Cable Television*
- *Mobile Radio*
- *Broadcasting*

Discussion

In general, terrestrial telecommunications facilities offer substantial capability at attractive prices for the relatively short point-to-point distance within a metropolitan area. For telecommunications between metropolitan areas, however, satellites can be competitive with terrestial systems. More specifically, for most applications within the metropolitan area requiring telecommunications support, the usual common carrier services, typified by the public switched network and including the services offered by the specialized carriers, should be the media of choice.

The potential for utilizing cable television facilities within the metropolitan area to satisfy a large class of applications has yet to be fully exploited. Satellites could be a technically important means to support cable TV in a metropolitan area by functioning as a wideband trunking medium between areas. Use of satellites as a trunking medium furthers the origination of programs from different geographical points. By contrast, satellite technology for cable distribution between points within a metropolitan area would not appear to be important in the near future.

For communications between points within a metropolitan area, satellites are not a promising medium for mobile radio either. To the extent that mobile radio may provide the "end-link" for communications originating in distant areas, the consideration whether the long-haul portion should be via satellite will depend upon factors essentially unrelated to the mobile radio field.

Satellites for broadcasting within metropolitan areas do not appear to be important. However, for broadcasting applications on a regional or national basis, satellite technology could be useful. The extent to which transmission via satellites is utilized between metropolitan areas will be determined by economic and operational considerations. In addition, satellites offer opportunities for extending a range of services to rural and remote areas.

ISSUE 8

Will demands develop for data communications services that will require different technical approaches to facilities than we now have, and a correspondingly different regulatory approach?

Discussion

There will be new and different demands for data communications services, and there will be a wide variety of new technical approaches and facilities to meet these requirements.

Turning to the part of the question as to whether a correspondingly different regulatory approach is needed, there are a number of basic national regulatory policies in existence:

- the need to assure the availability of required communications capabilities on an efficient and reasonable basis;
- major reliance upon regulated common carriers to provide the needed facilities at a fair price, recognizing a fair rate of return to the carrier, and upon a basis that is not unreasonably discriminatory;
- for some public telecommunications services, the public interest can be best fulfilled by emphasis upon a regulated "monopoly," but in some other foreseen public telecommunications services, the public interest might gain from the entry of competitive, non-regulated public services;
- the timely availability of some needed data communications equipment, with competitive stimuli for innovation and low cost, can be fulfilled by permitting the user to provide his own;
- there are some activities which, though clearly related to and dependent upon data transmission, are not common carrier activities subject to regulation as such. The data processing field is an example.

Allowing for such regulatory considerations, it is reasonable to forecast that anticipated developments in the demand for data communications services, and the technical approaches developed to meet these demands, may not require different regulatory approaches. The problems are likely to arise from efforts to determine the proper application of such regulatory considerations to specific developments and factual circumstances.

In terms of other regulatory aspects, whether basic policies will have to change may depend, for example, upon particular applications--for example, security networks, priority networks for public safety, and low data rates originating from homes.

ISSUE 9

Might the pattern of regulated telecommunications and unregulated data processing be reconciled well enough to accommodate the needs of the users for end-to-end service and satisfactory aggregation of skills and facilities?

Discussion

Present FCC computer policy attempts to permit both unregulated data processing and regulated telecommunications to exist and work together in a complementary fashion. However, there may be issues that need further rulings, such as the regulation of terminals. Because the FCC is re-opening its computer policy inquiry, the committee holds that its further study of this issue should be delayed or reconsidered at a more appropriate time.

ISSUE 10

Are there areas in which policies for domestic metropolitan telecommunications will have significant impact on the development of foreign markets and the U. S. ability to compete in those markets?

Discussion

It has not been possible to examine the many factors and implications of these questions during the course of this study, let alone provide a consensus of findings, conclusions, and recommendations. Seven committee members were members of an earlier study that addressed this concern, at a time when the U. S. had an overall negative balance of trade, and found that technology was only one limiting causal factor. 35/ Since that time, the U. S. balance of trade has fluctuated, due almost entirely to factors other than technology, though technology is still a prime force in the export market.

In the interim, an industry advisory committee has reported on this issue. 36/ A Task Force of the Office of Telecommunications has also circulated for comment a draft report that, in part, addresses the question. 37/ Thus, the Committee on Telecommunications, presented with a topic on which a consensus has been found difficult to achieve in other studies, finds that the factors exogenous to the

telecommunications industry are controlling. Nevertheless, there are three basic areas in which the committee can contribute to this issue:

- To the extent that cost-effective approaches are identified as solutions to urban needs, the entrepreneurial initiatives of the free enterprise system will bring them to domestic and foreign markets without further government intervention. Government policies can assist in this identification by creating test beds for evaluating the technology in terms of whether it has sufficient utility (as seen by its ultimate users) to justify its price. When we get through the cycle of identifying appropriate test beds, it is pre-supposed that those that are cost-effective will stimulate new competitive product offerings by U. S. manufacturers.

- The government is also capable of stimulating innovation in areas where it is in the market for telecommunications equipment, such as for the military or space programs.

- One important contribution to the U. S. balance of payments in the future is likely to come from the sale of information services to foreign markets. To enhance the growth of this market, it is recommended that the development and approval be strongly encouraged for international telecommunications that are effective and cost-competitive for a wide range of data processing services.

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